GRAPHIC SCIENCE

THE MAGAZINE FOR DRAFTSMEN

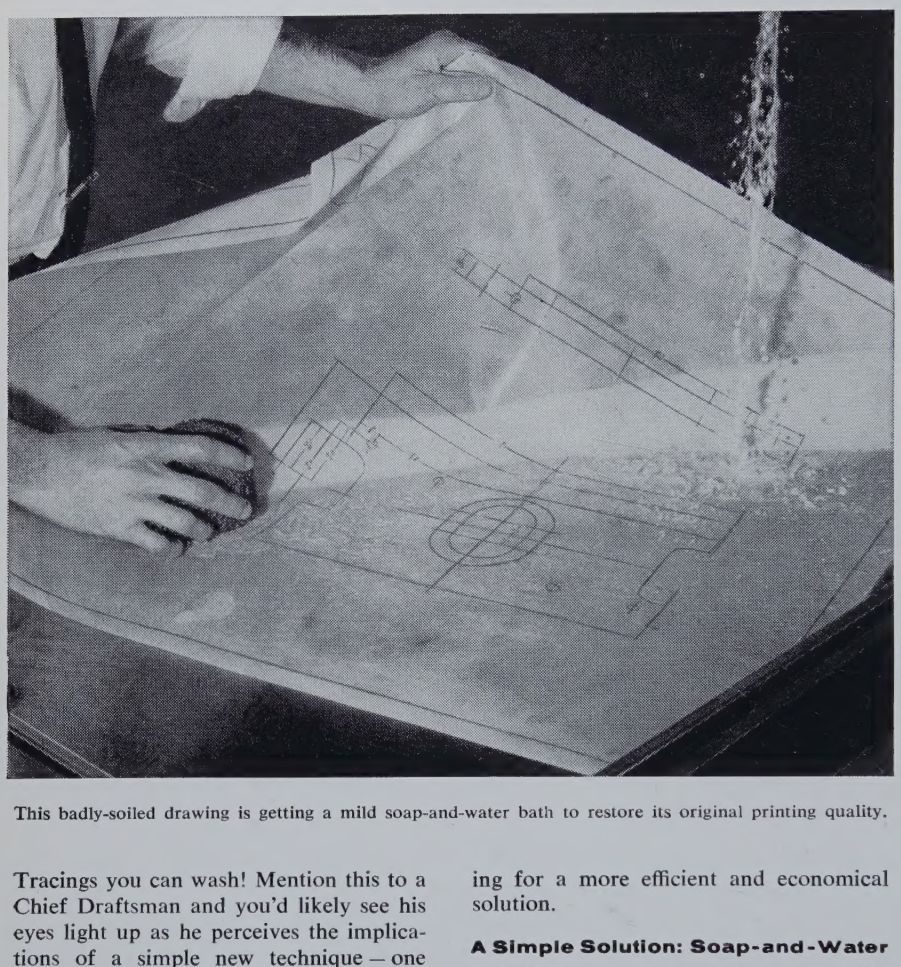
DRAWING COST CONTROL

JANUARY 1960

Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.



This badly-soiled drawing is getting a mild soap-and-water bath to restore its original printing quality.

Tracings you can wash! Mention this to a Chief Draftsman and you'd likely see his eyes light up as he perceives the implications of a simple new technique – one that's being used now by Raytheon Co. and could save them at least $50,000 this year. The secret: Herculene® Drafting Film by K&E, plus Staedtler Duralar plastic pencils –a completely washable combination, and the answer to . . .

A Dirty Old Problem

Functionally, an engineering drawing is only as good as the prints it will produce. This is a fact of life that governs any distribution-print system – conventional blueprints, white prints, or reduced-size prints. It holds true in a full-fledged miniaturization program, too. How long will an original tracing continue to produce top-notch prints? The answer depends on how much and what kind of handling it receives. Revisions, smudging, processing and filing all take their toll of a drawing's printability, decreasing it gradually – and sometimes quite sharply. As printing quality diminishes, some form of rehabilitation becomes necessary. But re-drawing – whether manual or photographic – can be costly and time-consuming. Drafting and reproduction experts have been wishing and working for a more efficient and economical solution.

A Simple Solution: Soap-and-Water

Washing became a possible answer with the advent of polyester-base drafting films and plastic pencils – and a practical reality with Herculene. This remarkable film combines a stable, waterproof Mylar® base with a completely washable surface for smudge-proof Duralar pencil lines – which *bond* to the Herculene surface and won't wash off.

Only the dirt washes away. There's no loss of line-background contrast, no loss of detail. The tracing can be restored to its original condition in a few moments – without re-drawing!

A Proved Money-Saver

To amplify an earlier point: the Missile Systems Division of Raytheon has been washing Herculene drawings for the past year, and now expects to save over $50,000 on re-draws alone in the year ahead. A large aircraft manufacturer has used the Herculene-Duralar soap-and-water method even longer, and reports impressive dollar savings plus an outstanding improvement in print quality.

In 6 months of testing and 14 months of actual drafting-room use, Raytheon engineers exposed Herculene to all basic trials – and a battery of fiendishly extreme conditions. They scored Herculene with a sharp scriber, but couldn't remove the matte surface. They taped a sheet to the floor and had a 200 pounder roll over it in a swivel chair during an active day. Herculene was baked and frozen – and doused with hot coffee – with no effect on its surface. After two hours, the coffee stain was washed off without a trace. Results of these torturous tests were so favorable that now, Raytheon's Missile Systems Division uses practically no drafting film *but* Herculene!

A Note of Caution

There are other waterproof drafting films, but plastic pencil lines will wash off some of them. So, when comparing polyester-base films, it's best to check them for *pencil line washability*. And another point – don't try this technique with ink or graphite lines – use only the Duralar K1 or K2. Even if you don't want to adopt the washing technique immediately, you're free to make the change at any time if you use Herculene – the *indestructible* drafting medium with the washable, engineered surface.

More Merciless Testing Invited

We'd be pleased to send you a sample of Herculene, and we invite you to do your best to ruin its excellent drafting and printing quality. The Herculene sheet comes in a small folder with complete instructions and a water-fast Duralar pencil – which K&E engineers helped develop for use with washable Herculene Drafting Film. Mail the coupon below for your sample!

KEUFFEL & ESSER CO., Dept. GS-1, Hoboken, N. J.

Please send me further information about the washable tracing method, plus a sample sheet of Herculene Drafting Film and a Duralar pencil.

Name & Title_____

Company & Address_____

_____

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GRAPHIC SCIENCE

THE MAGAZINE FOR DRAFTSMEN

JANUARY 1960

VOLUME 2 NUMBER 1

ARTICLES

DEPARTMENTS

GRAPHIC SCIENCE—offering complete coverage of drafting, technical illustration and reproduction for chief draftsmen, supervisors and instructors.

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Letters

Sirs:

I have been fortunate to have never felt I was one of "the lost generation" or "underprivileged" as some of your readers seem to regard themselves. I have worked northeast, southwest and deep south and believe draftsmen in general are well paid for drawing straight lines and circles.

The average draftsmen I have worked with have an inflated feeling of self-importance or indispensibility. Yet they come and go and lost time or inconvenience is seldom felt within the drafting room. My point is proven by most of your reader's letters expressing joy and approval to have a publication solely for this minority group of workers who, let's face it, have it made.

I hope to see more pointed articles such as that of "Printed Circuit Masters" which appeared in GS Oct. 1959. I have already found the Check List a very useful guide.

DAVID M. SEALE

Dedham, Mass.

Sirs:

The need for formal recognition of the drafting profession has long been felt and you, through Graphic Science, have made a valuable contribution to this end. However, another important milestone would be the formation of an American Society of Draftsmen. Your magazine may be a good sounding board from which the degree of interest in such a society could be obtained.

I would like to obtain *Volume 1, Number 1* of Graphic Science. The attached information is supplied in order to receive subsequent copies of Graphic Science for myself and four (4) Supervisors Drafting.

Best wishes for continued success with Graphic Science.

D. A. CONLEY

General Electric Co.
Hanford Atomic Products Operation
Richland, Washington

Sirs:

Congratulations on the new arrival, Graphic Science. There is and will continue to be an increasing need for the dissemination of information pitched to drafting people.

The title, "Draftsman", is by its very nature ambiguous; perhaps your magazine eventually will point up proper definitions. May Good Luck and Success reward you and your associates on this new approach.

FRED CUMMINGS

General Electric Co.
Gas Turbine Division
Schenectady, N. Y.

Sirs:

Graphic Science can well fill a gap in the drafting business. This gap is good communication and a source of technically reliable information to the draftsman. The writer has written, taught, and been an advocate of Functional Drafting for fifteen years. However, efforts in this direction have met only with mediocre success. Not because of unsound ground rules but because of limited efforts and communication spread too thin.

It is indeed unfortunate that so many draftsmen have a misconception of Functional Drafting. Personal pride and emotion have kept many from giving this area an objective look and trial. The final judges of any drawing are those who must use it as a working tool. The drawing is not the end in itself but only a step to a goal—the finished product. With this in mind I will stack Functional Drafting against classical methods any time.

Functional Drafting will produce a better "use document" usually, but not always, faster than classical methods. Production shops and tooling people will find the drawing more readable and easier to use. Probably this is why the staunchest advocates of Functional Drafting in many cases are ex-production shop people now in drafting departments.

Possibly if Draftsmen who feel they are the "lost generation" or underprivileged had advanced with the times their lot would be better today. In most cases management will pay for industrial efficiency. If Draftsmen care to exhibit this by producing a better document faster, their status will improve.

Congratulations on a needed publication.

R. E. MEYERS

San Francisco Naval Shipyard
San Francisco, California

Sirs:

Your new publication was received well by our group. We feel it is a much needed addition to the drafting publication field. The first issue indicates an editorial approach to deal with specific problems where the state of the art is advancing rapidly such as the articles on scribing and dialing. This will make the magazine of value to pioneers in the specific field as well as to the newcomer to the field.

We have been using scribing materials for a considerable length of time. We would have appreciated the article more if we could have seen photographs of the scribing tools and also a listing of the manufacturers of these tools with approximate costs.

A similar comment can be made on the dialing article in that this area is advancing rapidly and there is a lack of information today on just what manufacturers are working on this, what their line of effort is and the relative cost of their equipment.

H. A. GIBSON

General Electrical Co.
Aircraft Gas Turbine Div.
Cincinnati, Ohio

Sirs:

The ideas that follow on "Getting the Most from Inexperienced Draftsman" were prompted by the request from one of your readers in a letter in the November issue.

If a draftsman recognizes that he is inexperienced and wishes to im-

(Letters to the editor should be addressed to 103 Park Avenue, New York 17, New York. Names will be withheld upon request but all must be signed.)

prove, the task of getting the "most" becomes a matter of patience, time and practice. The supervisor's recognition of the point where inexperience stops and experience begins will have an important bearing on the success of the instruction and on the quality of the product the draftsman eventually produces.

Other factors that must be considered are the inexperienced draftsman's previous schooling, if any, and his familiarity with blueprints and projections. It is pretty evident that the progress of the inexperienced draftsman will be proportional to the amount of his own interest and the help he receives.

Here are some of the ways to help: (1) Recognize his limitations. (2) Provides a suitable working area for him. (3) Encourage him. (4) Assign projects within his abilities, letting them get more difficult as he gains confidence and skill. (5) Give him all the information he requires in a form he can understand. (6) Provide reference books, standards, catalogs, etc., or tell him where to get them. (7) Allow some time for practice on weak spots. (8) Provide complete equipment, the best the company can afford. (9) Arrange for cooperative training.

Somewhere, of course, we get to "Supervising the Experienced Draftsman" and that is a problem in its own right!

GEORGE H. FROST
Portsmouth Naval Shipyard
Nuclear Power Division
Portsmouth, N. H.

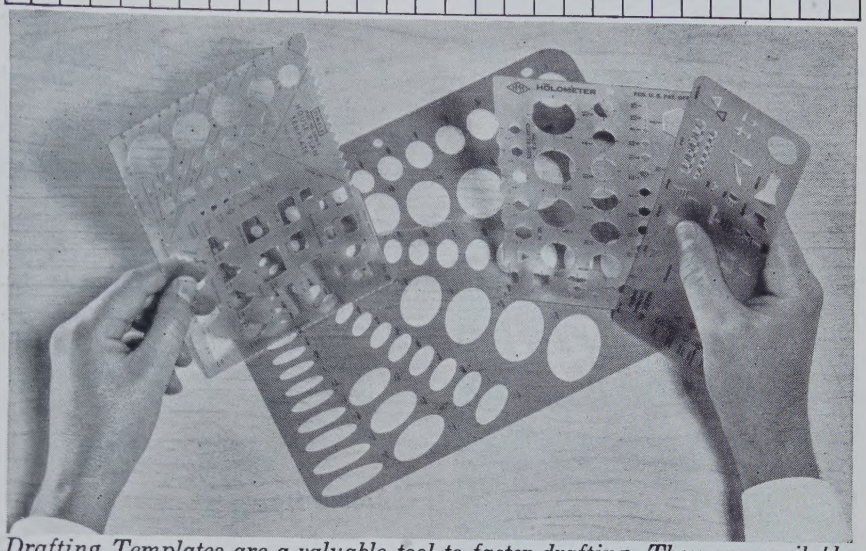
Sirs:

When asked what magazines are a necessity in the drafting field, you may be sure that Graphic Science will top the list. I have found, and I am sure others have too, that Graphic Science is one of the most interesting and informative magazines available. In my opinion it is a must for every draftsman. I was introduced to Graphic Science by the October issue and found that I am eligible to get copies. I feel that this magazine will prove to be of great value and assistance to me.

ALBERT W. BAUM
Atlantic Research Corp.
Alexandria, Virginia

(*Continued on page* 34)

DRAFTING TRENDS



Drafting Templates are a valuable tool to faster drafting. They are available in an almost endless variety.

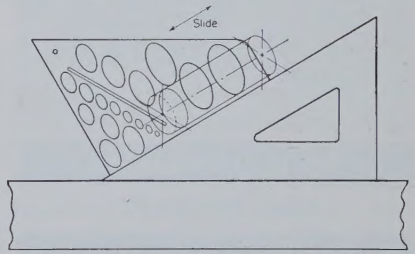
Specialized drafting templates speed drawing time

Always a handy tool, drafting templates are becoming increasingly in use to simplify everyday drawing techniques. Now vinyl plastics are used in the manufacture of the majority of templates. But the thickness, color and finish vary in almost endless profusion. Glare-saving colors, such as green and amber, are usual, both in clear and matte finishes. However, the white and clear plastics still are popular. The thicknesses vary with the different types of available templates from .020 gauge through .070 gauge.

Specialized template applications

A list showing the growing application for templates includes templates for: Electronic Symbols, Electrical Wiring, Landscaping, Screw Heads, House Plans, Nuts and Bolts, Screw Threads, Tooling, Windows, Plumbing, Mathematical Symbols, Map Planning, and many "all-purpose" templates for circles, ellipses, triangles, and other shapes.

Isometric ellipse template is a big timesaver



An isometric ellipse template may be more useful if it is cut in half to provide edges parallel to the minor axes of the ellipses. Halves of the template may then be moved along a 30-60 degree triangle so that ends of a shaft or any cylindrical shape can be drawn in a minimum of time and in perfect alignment.

A selection of 52 popular templates is illustrated and described in a special six page brochure, "Drafting Templates" recently published by Frederick Post Company. *For your copy, write Frederick Post Company, 3656 N. Avondale Ave., Chicago, Illinois.*

Notes & Comment

THE DIVISION of Engineering Graphics of the American Society for Engineering Education will hold its mid-winter meeting at the Rolla School of Mines and Metallurgy, Rolla, Mo., January 20, 21 and 22, 1960.

Chairman of the host committee is Lloyd Christianson, head of Rolla's Graphics Department. Irwin Wladaver—Graphic Science Associate Editor and Associate Professor of Engineering Drawing, College of Engineering, New York University, will preside at one of the sessions.

For more information: Lloyd Christianson.

International

ENGLAND: A group of 33 persons are included in the Standards Section of Rolls-Royce Ltd., English manufacturer of automobiles, aero engines, diesel engines, rocket motors, and nuclear reactors. Of the four volumes of standards for which the group is responsible, only the fourth—on Drafting—is not as yet complete, according to a spokesman for the firm.

RUSSIA: Unification of drafting standards is being achieved within the communist countries allied with the USSR according to an article appearing in the USSR magazine, *Standartizatsia,* partly translated in the ASA publication, *The Magazine of Standards.* The article reported the results of a meeting held last year. At the meeting, according to the article, a unified system pertaining to technical drawings was elaborated that defined standard scales, letter symbols, projections, cross sections, dimensioning, etc. It said, "The common technical language used in drawings will make it possible to avoid the necessity of redrawing in each of the individual countries, because the adoption of a unified practice of presenting technical drawings will make them easily understandable in all other socialist countries, thus saving both labor and time." Its conclusion:

"Scientific and technical cooperation of communist countries in the sphere of standardization will also greatly help the International Organization for Standardization (ISO) to which most of the socialist countries belong."

Automation

GENERAL ELECTRIC'S Specialty Control Department in Waynesboro, Virginia, has succeeded in producing program tapes from dimensionless engineering drawings, using a Haag-Streit Coordinatograph. The programmed tapes, estimated to save 75 per cent of previous drafting time, are being used to control the operation of a 100-ton turret punch press.

The procedure GE uses involves preparing a layout with drafting templates. Punch positions are "found" by an operator using selector switches on a control console. The locating device on the Coordinatograph then centers over markings on the templates for the punch that is desired. The x and y dimensions as measured by the locating device are transferred from the layout to storage and read-outs by a controlling foot switch. A second foot switch controls the punching of the tape, simultaneously marking the layout via the locating device. This reduces the possibility of repeating holes, and also gives a visual record of programmed material.

A duplicate of the marked layout, made by diazo, is marked with specifications of part numbers and a drawing number, and duplicates of this become assembly drawings.

Duplicated tape and an accompanying specification sheet are produced by automatic typewriter, again via programmed tape, to provide additional visual checks.

Another Merger

PARAGON - REVOLUTE, Rochester, New York, has become a division of the Charles Bruning Co., Inc., Mount Prospect, Ill., according to a December 1 announcement by L. Gordon Booth, Paragon - Revolute president. The firm, a manufacturer of blueprinting and allied reproduction equipment, will continue its manufacturing, production and sales policies without change.

An Engineer Looks at His Draftsman

First steps in defining murky areas of responsibility

by Lee E. Fickle

THE RELATIONSHIP of the electrical engineer and his draftsman is, to use a simple analogy, similar to viewing light through a prism. The color of the light changes as the location of the viewer changes with respect to that prism. In like manner, the engineer-draftsman relationship changes, with the job at hand acting as the prism.

At one time or another most engineers, either during summer vacation or a first job out of school, have spent considerable time "on the board." As a result their understanding of the many hours of toil necessary to produce a final drawing ready for construction is very keen. However, as the engineer gets further away from the days he spent at the drafting board, he tends to forget a few of the basic relationships.

Economically speaking, the time of most engineers is relatively expensive, compared with that of draftsmen. Therefore, one of the basic relationships is the time saved by the draftsman who takes the ideas, sketches, and designs of the engineer and translates them into workable, readable drawings. This brings up a question which can be answered only by the individuals involved; i.e., at what point does the engineer stop sketching and designing and where does the draftsman start? What items affect this fuzzy, grey zone of responsibility?

As the result of an education based primarily on absolutes and so-called "hard facts", many engineers tend to be positive and occasionally autocratic. This item, not to be overlooked, places a very grave and unnecessary strain on the engineer-draftsman relationship. All too often the engineer will provide only the sketchiest information and will expect the draftsman to fill in details requiring technical training beyond his scope as a draftsman. This is unfortunate for all parties concerned.

In contrast with the foregoing relationship, more often we see a close coordination between engineer and draftsman, and the drawings that result are clear, detailed and effective.

THE OTHER SIDE

To the electrical engineer engaging in design for an industrial company, the draftsman is more than a technician schooled in transferring pencil lead to paper. He is a friend, checker, detailer, critic, and quite often a sounding board for the ideas, theories, and hopes of the engineer. His "commercial friendship" is the common bond between the two and with the firm for which they work. It reflects a genuine interest in the project at hand. The draftsman is a checker of minutiae. His background permits him to relieve the engineer of repetitious tedium. He is quite often the indispensable *general factotum,* seeking out tracings and prints that are forever straying, measurements that are never shown, and field data that the engineer never "seems to have at hand." He is a critic—in the friendly sense of the word—of the engineer's design. Quite often these designs are enhanced by the draftsman. As a sounding board for the translation of the engineer's theories, ideas, and designs from sketch to working drawing, he is invaluable. He listens patiently, adds his knowledge, and puts the results on paper.

The end point of such a relationship is the presentation of the engineer's ideas and designs in a manner that is pleasing and acceptable from every aspect to all the people involved. In short, the electrical engineer needs the constant support of a competent, interested draftsman. If the relationship works both ways, as it should and usually does, the draftsman and the engineer are both pleased with their work and the company is well off indeed.

The Author

LEE E. FICKLE is an electrical engineer for Eli Lilly and Company, Indianapolis, Indiana.

Scribe System for Printed Circuits

Special scribing instruments, peel-coat polyester-base film, and photographic techniques supersede former materials for printed circuit work at General Electric Company

IN THE MIDDLE 1950's, techniques proven satisfactory for earlier printed circuit work began to exhibit less than satisfactory results for preparing the complex and specialized circuits handled by General Electric Company's Heavy Military Electronics Department, Syracuse, N. Y. Mounting costs were disrupting schedules and budgets.

To meet this situation, a new scribe technique for printed circuit layouts was devised by GE's drafting personnel in cooperation with the Keuffel & Esser Co., Hoboken, N. J. It consisted, briefly, of outlining the lands and circuit paths with special scribing instruments and then stripping them out through use of a photographic resist-coated polyester base film.*

No newcomer in GE printed circuit work, the polyester-base film was developed originally for the Army Map Service. However, the scribe tools used to make maps were not suitable for printed circuit work. This difficulty was overcome when the joint effort between GE and K & E resulted in a new type of scribe instrument.

How it Works

THE NEW METHOD of preparing printed circuits works as follows:

1. Standard circuitry is scribed on scribe-coat polyester-base film.* This is called the scribe master.

*Both scribe-coat and peel-coat polyester-base films are varieties of Stabilene, a trade-name product of Keuffel & Esser Co., Hoboken, N. J. The base of Stabilene film is Du Pont's Mylar, restabilized by K. & E.

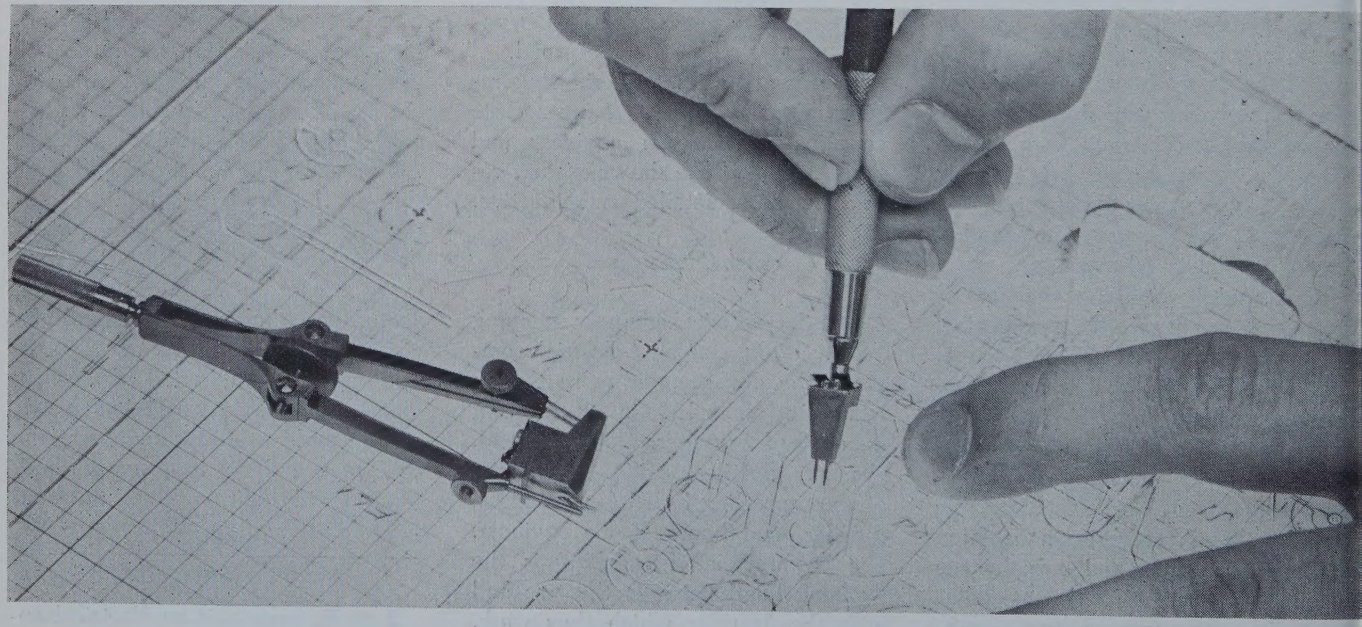
2. Photographically, peel-coat polyester-base film* is exposed to the scribe master. This produces a line image on the photo emulsion layer of the sheet. The area between each translucent line, not the line itself, is actually the circuit path desired.

3. While in the developer, these image lines are eaten away, down to the peel-coat layer.

4. The sheet is then wiped with an alcohol-dampened cloth, further dissolving the image lines through the peel-coat layer and down to the base film. Valleys, two layers deep, result.

5. The photo emulsion layer of the sheet is then washed away in a chlorox bath, leaving valleys now only in the peel-coat.

6. Finally, the coating between



SPECIALLY designed scribing instruments equipped with spring-type shock absorbers are used to "outline" circuit paths and connection pads. These devices maintain precise accuracy on curved lines as well as straight ones for printed circuit work.

each translucent line is peeled away, leaving finished circuit paths. This final master and file copy can be further reprinted.

The increased accuracy obtainable with the new scribing system is attributed to three factors. First, the scribing instruments' steel alloy points (shaped like phonograph needles) are made in graduated widths; they cut sharp, precise lines. The use of constant-width scribe points is said to eliminate minute variations in circuit line widths often resulting from pen and ink work, where the amount of ink in a pen can alter line thickness and clarity.

Second, the polyester-base film on which the scribing is done contains grid lines for accurate positioning of the board element. The film itself is said to have exceptional dimensional stability, permitting precise reproduction and maintaining constant line character under extreme temperature and atmospheric conditions.

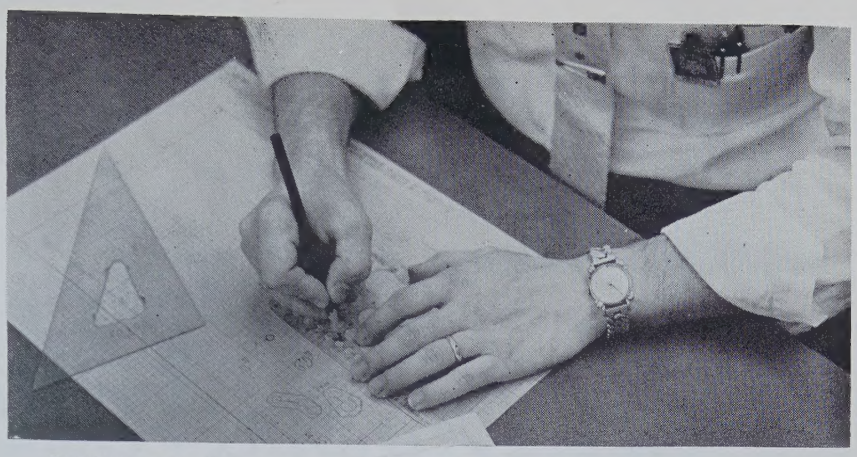
Third, the new scribing tools are equipped with spring-type shock absorbers. They maintain the same accuracies on curved as well as straight lines, eliminating ragged circuit paths. Unlike ordinary scribers or drawing instruments, the new devices outline a circuit line. Thus, two accurate, separate lines are scribed into the film to outline what will later be a solid line.

The new scribing method is also said to be very flexible. For example, optimum use can be made of the board area, since the width and length of runs, as well as pad (connection) sizes are not limited.

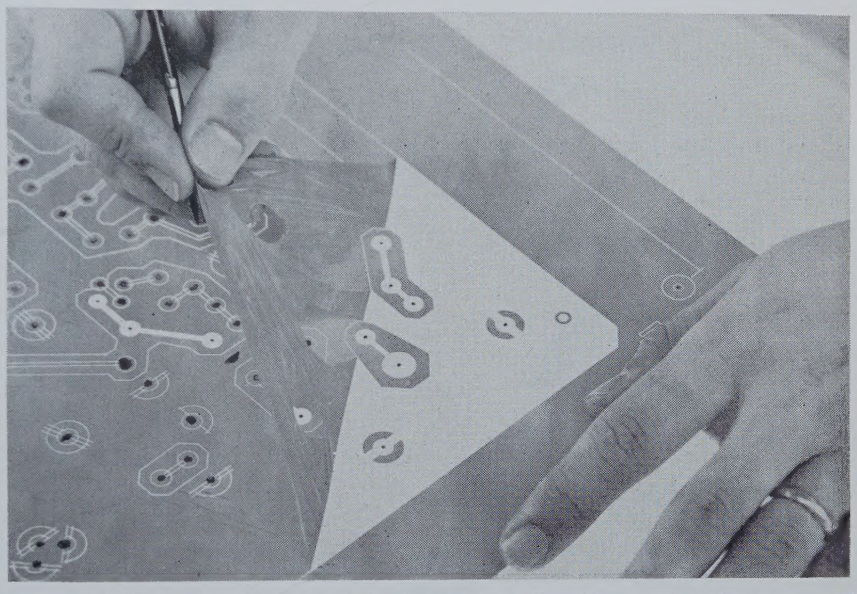
A final point, drawing changes can be made during any one of the three steps: on the original scribed layout, peel-coat negative (intermediate step), or the final layout. Specially formulated fluids are used.

The Savings

According to H. A. Knowlton, General Electric drafting supervisor, use of this new technique in the preparation of 300 different circuit layouts has resulted in a saving of $27,000. Company manufacturing experts cite a recent production job involving several complex boards, in which 30 hours were needed to prepare each printed circuit layout using the new system, as compared with 80 hours using the tape method, a saving of 50 hours per printed circuit board.

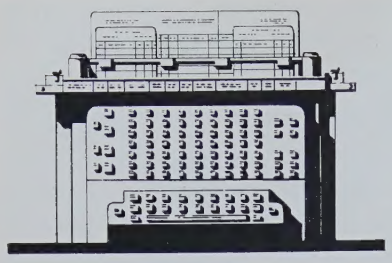


ORIGINAL drafting layout is done directly on scribe-coat film master which contains grid lines for accurate positioning of printed circuit board elements.



AFTER scribe master is processed photographically, film coating between each translucent line is peeled away, leaving finished circuit paths and connection pads.

SCRIBE METHOD for preparing printed circuits: (1) scribe master, (2) peel-coat intermediate negative, and (3) final master print, twice-size of printed circuit board.



Get Drawing Cost Control

Standard accounting procedures and well-kept records enable the drafting department supervisor to monitor performance against previously established estimates

by Harry M. Perks

ENGINEERING is sometimes regarded as a field which defies estimating and cost control procedures. This may be true where basic research or problem analysis is involved but the engineering for a new manufacturing facility, for instance, is predictable even though it involves the cooordinated effort of a large group of engineers, designers, and draftsmen. We at Day and Zimmermann have been able to apply basic cost control procedures to our engineering effort.

Much has indeed been written on estimating the costs of a new facility, but very little on the estimating of engineering costs, and what is more important—their control.

Engineering costs in this kind of project may represent a segment of the total cost, varying from 3 to 15 per cent depending upon location and complexity of the job.

Discussion here is limited to the costs in connection with the preparation of drawings and specifications for a new manufacturing facility with general engineering supervision of construction. Here design and drafting charges amount to approximately 70 per cent of the total cost; our discussion will be further limited to this area.

The procedures and steps which will be presented are based on basic industrial cost accounting devices. The first of these is a Code of Accounts.

An Account is simply a number corresponding to an expense against which the accountant accumulates costs. The code of accounts is the complete list of these numbers and the items of work to which they correspond. It can be as simple or as elaborate as you want to make it. On large construction projects, for example, the code of accounts might consist of several thousand numbers.

Once the code of accounts has been established, the next step is to establish a budget (or appropriation) for each account number. This budget is a target and is developed from previously accumulated historical data and an analysis of the project at hand.

A system to accumulate and summarize costs in accordance with the code of accounts must also be established, and it must be simple enough to permit meaningful cost data to be readily available for study.

With these aids, the next step is a production analysis of the per cent of the money spent and the per cent of work finished for each item on the budget.

This evaluation is the purpose of the entire system. It makes it possible to revise the first estimate at the earliest possible date, and to feed final data back into the historical records for future use in estimating.

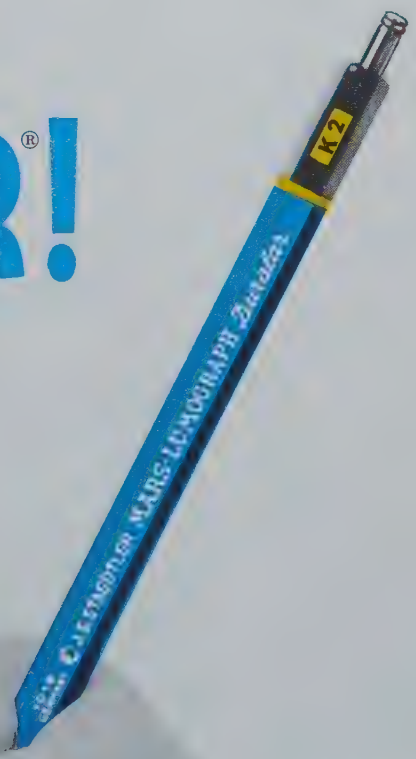
Organization

IN ORDER to understand the detailed system that is to be presented, it is essential to know a little of the organization for which it was designed. Needless to say, the implications of it are applicable to companies other than ours.

All of the designers and draftsmen who work for Day and Zimmermann are assigned to the Design Division. This group has varied over the last ten years from 75 to 300 men. The Design Division is headed up by the Chief Draftsman and is subdivided into six categories: Civil or Yard, Architectural, Structural, Building Service, Electrical and Mechanical.

Each of these is further divided into squads supervised by a Squad

WON'T SMEAR ON MYLAR®!



Duralar

Still the only pencil

that **can't smear** on Mylar, that **keeps a point** on Mylar, that **erases** on Mylar. Duralar drawings on Mylar **reproduce** perfectly, **microfilm** without loss and can even be **cleaned** with soap and water.

For free samples

of Duralar pencil and leads and leading brands of matte-surface Mylar drafting film, just fill out the coupon and attach to your business letterhead. See for yourself how the sensational new Mars Duralar solves your drafting problems. And Duralar is available pencils, leads and lead holders) in five special new egrees of hardness (K1 to K5). Sold at leading engineering and drawing material suppliers.

NEW! No. 555 Duralar Eraser

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Another first from

MARS

J. S. STAEDTLER, INC. HACKENSACK, N. J.

Gentlemen: Please send me FREE

- ☐ Samples of revolutionary DURALAR pencil and leads
- ☐ Samples of Mylar film for testing DURALAR
- ☐ A copy of the booklet "The Advantages of Using Mylar Drafting Film"

NAME _____ TITLE _____

FIRM _____

STREET _____

CITY _____ ZONE ___ STATE _____

Leader. Squads usually range in size from 6 to 12 men, depending on job requirements. Our accounting procedures are intended to control the production rate of these small groups engaged in the preparation of drawings.

Accumulating Historical Data

Any estimate is ultimately based on the cost of each drawing. Likewise, in order to be able to compute the per cent cost expanded for each account, as in the Code of Accounts, it is necessary to have a cost book divided up by account numbers. This then is all that is required: one book to accumulate costs by drawings, and one book to accumulate costs by account number.

The mechanics of recording data are quite simple. Each day the designers and draftsmen break down their time on a "Squad Leader's Daily Report." On this the draftsman records the drawing title, its number, the type of work that he was doing, and the time he spent to the nearest quarter hour. The different types of work are broken down into the following classifications:

(1) Supervision
(2) Preliminary
(3) Design Calculations
(4) Final Drafting
(5) Checking
(6) Alterations
(7) Revisions
(8) Field Trips
(9) Miscellaneous
(10) Vendors' Drawings

These Squad Leader's Daily Reports are posted daily by drawing and identifying the classification of work performed on that drawing.

They are posted weekly into a cost ledger by account number. The information in the cost ledger is used in preparing periodic progress reports which will be discussed later.

At the end of each project these historical data are compiled on a single sheet in two tabular forms. (See Figure No. 1).

In the first tabulation, all the time spent by each group is broken down into the various types of work. This tabulation serves two purposes.

First, it is helpful when conducting "post mortems" on completed projects. For example, if the production rate for the drawings was high perhaps there was too little, or too much

CLIENT _____
PROJECT DESCRIPTION _____ P O. No. _____

SYM	DESC	CLASSIFICATION													
		YARD		ARCHI		STRUCTURAL		B. S.		ELECTRICAL		MECHANICAL		TOTAL	
		HRS	%	HRS	%	HRS	%	HRS	%	HRS	%	HRS	%	HRS	%
V	Supv														
P	Prel														
C	Calc														
F	Final														
K	Chk'g														
A	Alt														
R	Rev														
D	Field														
E	Eng'ng														
M	Misc														
G	Vend Dwgs.														
	TOTAL														

ACCT NO.	CLASSIFICATION	HOURS	% OF TOTAL	NO. DRAWINGS	NO. Sq Ft	AVERAGE HRS/DWG	AVERAGE HRS/Sq Ft
D-1	Yard						
D-2	Architectural						
D-3	Structural						
D-4	Building Services						
D-5	Electrical						
D-6	Process Mechanical						
D-7	Mechanical						
D-8	Flow Sheets & Inst.						
	TOTAL						

REMARKS

FIGURE 1. The two tabular forms shown here contain all the data concerning costs of drawings on any completed project.

supervision. Perhaps there was an abnormal amount of time spent in revising the drawings or perhaps the time spent on the preliminary work was high.

The second purpose is more important. In order to make an intelligent analysis of the progress of a drawing or to estimate the per cent a drawing is complete, it is necessary to have a knowledge of the per cent each phase in the development of the drawing contributes to a finished drawing. For example, if there is a structural drawing to be made and all the design calculations are finished, the drawing would be considered 20-25 per cent complete, even though actual drafting has not been started.

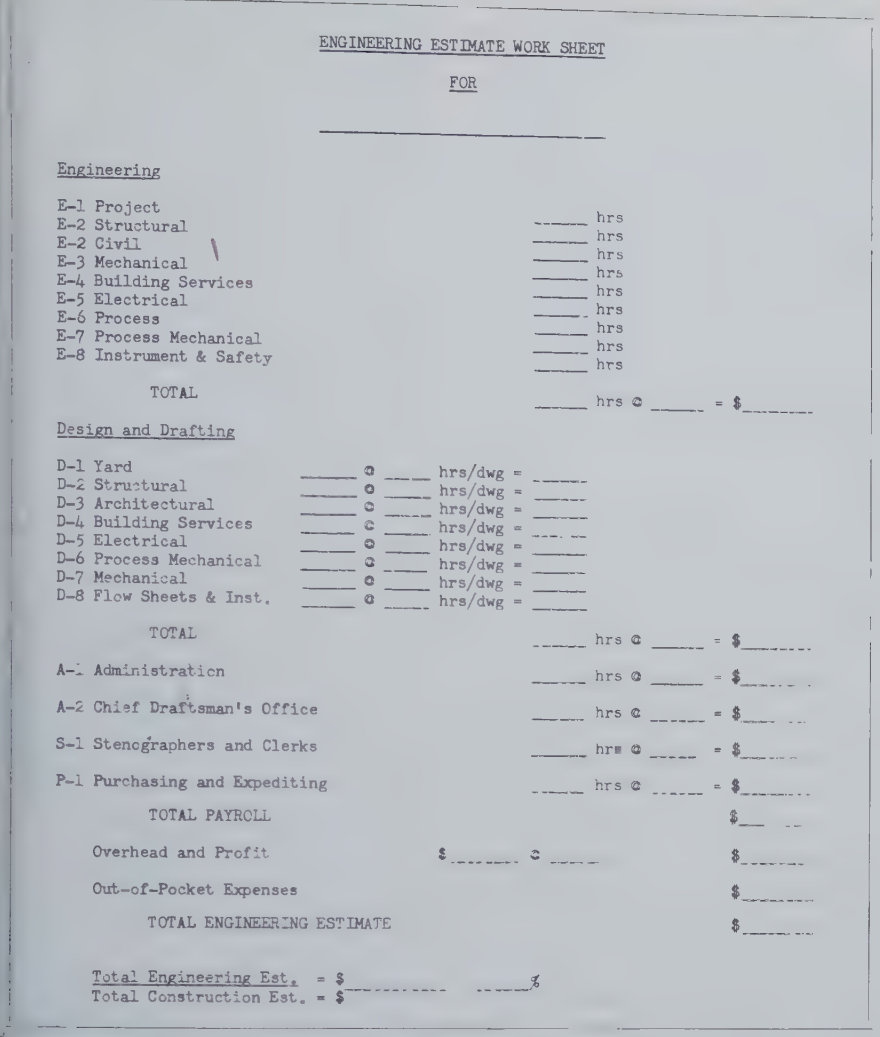
The tabular data at the bottom are strictly for future estimating purposes. Notice that the production rate for each group is given in both hours per drawing and hours per square foot.

This single sheet contains all the important historical data concerning the cost of drawings on any project.

The Estimate

An engineering and drafting estimate is prepared for every project before it is started. These estimates are necessary in order to properly plan the work. It is necessary to have a very good estimate coupled with a realistic schedule in order for the chief draftsman to have the men in sufficient numbers and of the required skills when they are needed.

The engineering and drafting estimate is always compiled on the same form. (See Figure No. 2). Notice that the design and drafting is broken down into groups which correspond to the groups on the historical data summary sheet. In order to estimate the drafting requirements, the project must be studied in suffi-



ENGINEERING ESTIMATE WORK SHEET

FOR

_____

Engineering

E-1 Project	_____ hrs	
E-2 Structural	_____ hrs	
E-2 Civil	_____ hrs	
E-3 Mechanical	_____ hrs	
E-4 Building Services	_____ hrs	
E-5 Electrical	_____ hrs	
E-6 Process	_____ hrs	
E-7 Process Mechanical	_____ hrs	
E-8 Instrument & Safety	_____ hrs	
TOTAL	_____ hrs @ _____	= $_____

Design and Drafting

D-1 Yard	_____ @ _____ hrs/dwg =	_____	
D-2 Structural	_____ @ _____ hrs/dwg =	_____	
D-3 Architectural	_____ @ _____ hrs/dwg =	_____	
D-4 Building Services	_____ @ _____ hrs/dwg =	_____	
D-5 Electrical	_____ @ _____ hrs/dwg =	_____	
D-6 Process Mechanical	_____ @ _____ hrs/dwg =	_____	
D-7 Mechanical	_____ @ _____ hrs/dwg =	_____	
D-8 Flow Sheets & Inst.	_____ @ _____ hrs/dwg =	_____	
TOTAL	_____ hrs @ _____	= $_____	
A-1 Administration	_____ hrs @ _____	= $_____	
A-2 Chief Draftsman's Office	_____ hrs @ _____	= $_____	
S-1 Stenographers and Clerks	_____ hrs @ _____	= $_____	
P-1 Purchasing and Expediting	_____ hrs @ _____	= $_____	
TOTAL PAYROLL		$_____	
Overhead and Profit	$_____ @ _____	$_____	
Out-of-Pocket Expenses		$_____	
TOTAL ENGINEERING ESTIMATE		$_____	

Total Engineering Est. = $_____ _____%
Total Construction Est. = $_____

FIGURE 2. The compilation of design and drafting cost estimates is made on this form before the project is begun. Form also shows the Engineering cost estimates.

cient detail to establish a list of drawings that will be required for each group. Once this list is established an estimate, based on the production experience indicated in the historical records is prepared.

No two projects are exactly the same. The procedure used is to pick a similar project or the average figures for a series of similar projects and adjust them in accordance with a knowledge of the project about to be undertaken. There are many factors to be considered.

Will this project be easier or more complex? Will there be any benefit gained from previous designs? How much duplication will be involved? How big is the project? What will be the relationship between the Owner and the Engineer? Does the Owner have an engineering force? Is the preliminary work complete? How will construction be handled? Will material take-offs be required? Will fabrication drawings be required? Who is available to assign to these projects in your own organization? Will it be a crash program?

Each of these things has an effect on the cost, some to a greater extent than others. Some affect the efficiency and others affect the amount of work to be done. But once these factors are all considered in the light of their importance, the estimate can be established.

This estimate is nothing more than an educated guess, but it is the best guess that can be made in the light of the data available and the knowledge of the new project.

This estimate, in summary, consists of the list of drawings and, in the light of the size of these drawings, the man-hours per drawing. This information is put onto the Engineering Estimate Work Sheet along with all the other items that make up the total engineering cost.

The Budget

The estimate, once established on a sound basis, serves as a budget for all phases of the engineering work applicable to the specific project. The budget consists of an appropriation in man-hours for each item in the Code of Accounts. The Code of Accounts appears on the Engineering Estimate Work Sheet; for the design and drafting it never consists of more than eight categories. The Code of Accounts can be much more elaborate than this but we have found that there has to be a balance established between the amount of detail necessary for a good control system and that which will enable information to be available in time for it to be useful.

Nothing is more useless than statistics that arrive after the need for them has passed.

The Budget is issued when a project is about to start so that everyone is fully informed. Everyone knows then what the target is and what the yardstick will be in judging performance.

Analysis of Progress vs. Cost

The code of accounts, the issuing of the budget, and the accumulation of the costs have all been briefly discussed. The most important feature of the entire system is the periodic analysis of the man-hours spent and the per cent of the work accomplished. The objectives of this progress vs. cost analysis are manifold:

1. It isolates trouble spots early so that corrective measures can be applied effectively.
2. It directs management effort to the areas where it is required.
3. It tends to make supervisors cost-conscious since they are notified in writing at the start of the project of their appropriated time, and periodically thereafter of their rates of progress.
4. It creates an interest in searching for simplified procedures and techniques.
5. It gives an opportunity for recognition of outstanding individuals and for weeding out of incompetents.
6. It enables re-evaluation of es-

timates in the early phase of the project so that the client and management can be notified of under-runs or over-runs.

7. It gives a complete picture of the total hours remaining to complete present commitments. This picture, analyzed in the light of the schedule of this and all other projects currently in progress, enables predictions of future man-power requirements and may serve as a guide to new business activity.

The size and type of project is important in setting up the paperwork. What is ultimately required is an analysis of the per cent of the budget spent with a per cent of the work complete for each item in the Code of Accounts.

On small projects involving only a few drawings all that is required is to go over each item of the budget and estimate the man-hours required to complete the work. Adding this to the man-hours already spent gives the revised estimate. The per cent of the work completed is simply a ratio of time spent, to date, to the revised total estimate.

The per cent of the budget expended is a ratio of the time spent to the original estimate. This information put in a simple tabular form would give the entire cost picture of a small project.

On very large projects—of more than around 300 drawings—it is impossible to analyze the progress vs. cost in this simplified way.

On a project of this size, it would take an extremely competent individual to make any evaluation of progress and final cost and compensate for all the changes, deletions, and additions to the scope without some sort of a system.

There are three major tools required to carry out an analysis on a project of this size. They are all interconnected:

1. Estimated man-power curves.
2. Drawing progress report.
3. Curves of time versus per cent progress and per cent of cost expended.

The estimated man-power curves, which are made in the early phase of the project, should be tied in with an estimate of the total drawings and an estimate of the total man-hours to complete the work. These curves take two forms.

1. The number of men versus time.
2. The total per cent of man-power used versus time.

These curves give the estimated completion date and a graphic representation of just how fast the work has to be done in order to meet this date.

A "Drawing Progress Report" is the key to the entire system of analysis. It lists the original estimates, the budgeted man-hours, the total man-hours used against each appropriation at the date of issue of the report, and the per cent of the budgeted man-hours spent to date. This gives a complete picture of what has been spent and is strictly a clerical operation, with the information being assembled from records in hand.

To arrive at the per cent of the work completed involves a great deal

(*Continued on page 29*)

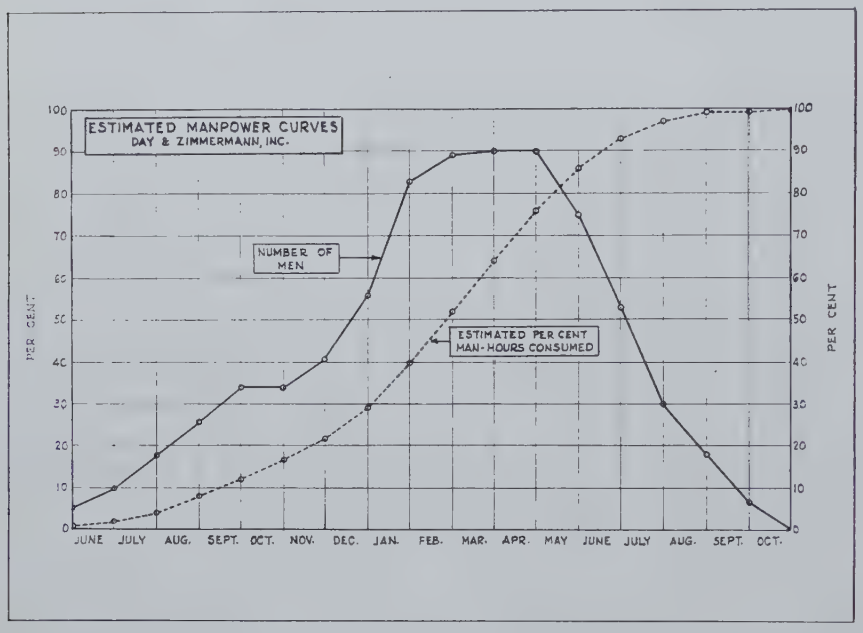


FIGURE 3. One of three tools used to analyze progress vs. cost and time on large projects. The two curves give a graphical representation of completion date and show how fast work has to be done to meet it.

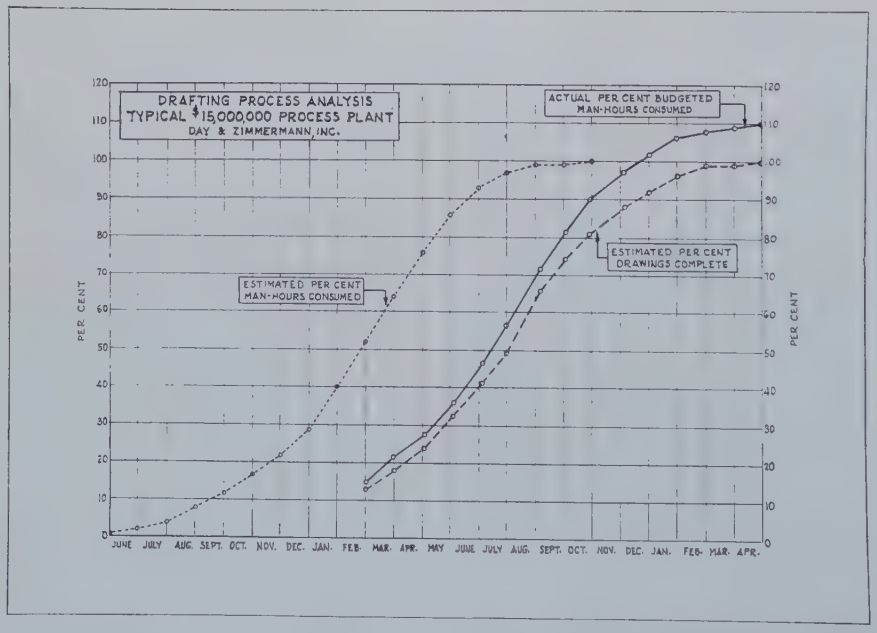


FIGURE 4. A graphical progress report, the third of the tools used to analyze progress vs. cost and time. Note that on this sample curve, when project with 40 per cent completed, it was 5 per cent behind; when job was completed budgeted man-hours over ran about 10 per cent, following slope of typical curve.

A Compendium of Drafting Aids

by A. F. Gagne

SIMPLIFIED DRAFTING has come to mean ways of reducing *unnecessary* lines and data on drawings—and this new technique has run into endless controversy because it is not at all certain that the savings in drafting time are not swallowed up by added shop costs. However, another approach to simplified drafting offers no such problem; it is the *how* rather than the *what*. By this we mean emphasis on worksaving tools and techniques which often improve drawing quality and utility.

I. PRE-PRINTING

THE PRE-PRINTING of all possible repetitive material is a primary time-saver. Such pre-printing starts with the drawing paper itself. There seems to be no good reason for failing to provide cut-to-size, pre-printed forms in all commonly used sizes. These save substantial time in lettering title blocks and drawing neat borders; they also rid the file of odd-sized drawings. The very small firm can buy stock forms for not much more than the cost of paper in rolls; the larger firm would do well to spend some time on designing a form to suit its needs. In some cases the form must be based on military requirements. If this is not a requirement, a simpler format is suggested, incorporating—besides the name and date essentials—such convenience features as standard tolerance data, change block, material and finish and next assembly number; see Figure 1. Unless desirable as a convenience or insurance against loss, omit the list of materials, which can be typed on a separate sheet at lower cost.

Draftsmen should never have to spend time drawing guide lines for lettering. This can be accomplished with a cross-section backing sheet under the drawing. Non-reproducing blue grid-lines can also be printed on the drawing in the title block area and in the drawing area as well. However, a test should be made to determine that the shade of blue selected will not be picked up by any of the reproduction processes to be used, this is particularly important when the microfilm technique is used.

The use of non-reproducing blue lines has recently been extended to the printing of optional material, such as power supplies for wiring diagrams, on the face of the drawing. This data is selectively traced in as needed. Rather than spend time tracing over such material, however, it may pay to pre-print each of the various alternates in black. With modern printing techniques such as Multilith and Xerography, or the many fine-quality, translucent intermediate reproduction materials available, a series of special formats can be inexpensively set up and stocked for repeating requirements; *viz.* wiring and pneumatic diagrams, chassis with different hole layouts, studs, spacers, cams and springs. Much of the work in the examples cited lies in drawing pictures and in lettering the notes. Since these are often 95 per cent standard, filling in a few blank spaces on stock forms saves checking time as well as drafting time.

When the location of the repeating elements changes, so that the drawing

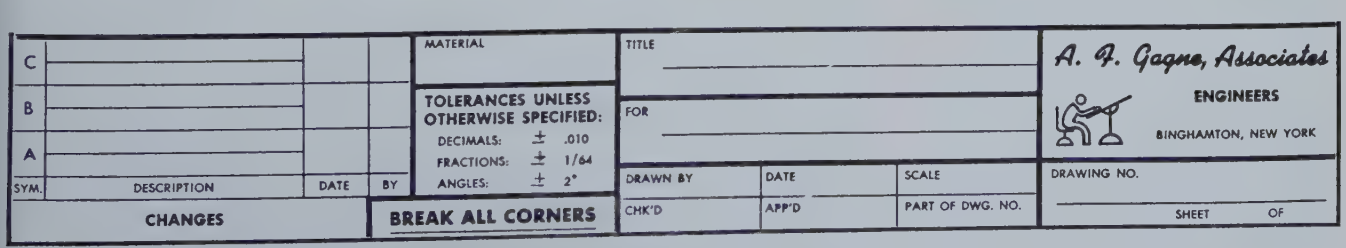


FIG. 1. Title block designed by the author includes all features considered desirable for commercial practice. Long, thin block utilizes otherwise wasted areas along bottom of sheet. Corners are rounded to minimize dog-earing, aid printing and filing.

cannot be effectively pre-printed, a number of other techniques are available. The rubber stamp has been used for title blocks and standard notes for many years, despite four limitations: drying time, uncertain quality, grey lines and uncertain positioning. New inks and pads have helped with the first two objections, while transparent stamps, recently introduced, have overcome the positioning difficulty; see Figure 2.

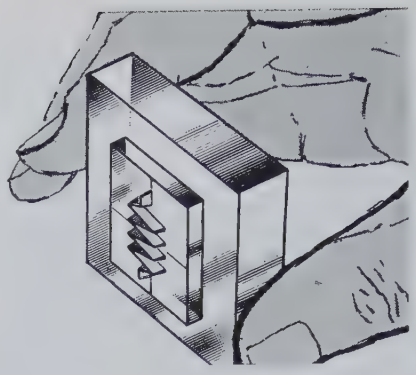


FIG. 2. Transparent acrylic stamp is easy to place accurately on drawing.

Appliques

Another type of pre-printing is the transparent, self-adhesive applique. Standard pneumatic, hydraulic, electrical, electronic and plant-layout components are available, see Figure 3. Custom units, such as hole or drilling patterns, architectural and mechanical components, special notes or warnings and title blocks, can be purchased in strips or rolls at nominal cost compared to the drafting time requirement. Some firms are completely sold on the applique; others have had trouble with certain types—trouble caused by bleeding adhesive picking up dirt in storage, by separation and wrinkling, or by heavy "ghost" backgrounds when several generations of intermediates must be made. One answer to such problems is to use the applique as a design tool, not as a print-making tool, and to create a permanent reproducible record later, by microfilming or similar photo techniques.

Templates

When a symbol consists of a few simple lines, the time required to select the applique from the file, cut it out, remove the waxed backing sheet and locate the symbol accurately on the drawing may be greater than the time required to use a cut-out or stencil template. One of the earliest stencil templates was a handy bolt-delineating guide. Now a great variety of templates is available at nominal cost, ranging from various sized squares, circles and ellipses to such specialties as fluid fitting templates drawn to precise scale.

In the case of the fluid fitting templates, it might seem at first that such painstaking delineation is a waste of time, no matter how speeded up. However, careful fluid component layouts have provided visual guarantees against interference. This is important as equipment has become more complex, more compact.

A variation of the stencil template is the lettering template. This equipment is limited with regard to maximum character size, but it is inherently faster than cut-out templates because no shifting is required to create a complex symbol. In addition to lettering, scriber guides find application in such special applications as electronic diagrams, trademarks, welding and mapmaker symbols. Custom-engraved templates can be ordered giving characters up to two inches high.

Another type of template is placed under the drawing and traced. This type of tracing template is suited to complex figures and is little subject to size limitations. While draftsmen have been tracing portions of other drawings for years, what is distinctive in the tracing template is the idea of selecting and approving standard components or assemblies and reproducing these in a form readily available to all users. Size for size, the tracing template is by far the cheapest of all to prepare. It has been used effectively by a number of jig and fixture hardware concerns as a product promotion device; a portion of a tracing template is shown in Figure 4. Gradually its application is spreading into such areas as air cylinders and architectural components. A further extension of this idea is a series of quarter-size, head-on photos of instruments and controls, intended for use in panel and process layout.

Some firms have found tracing templates such as that shown in Figure 4 of considerable value in their own drafting rooms. If close dimensional accuracy is essential, stable media are available for both original and prints.

FIG. 3. Electronic appliques in tabbed file supply many standard symbols.

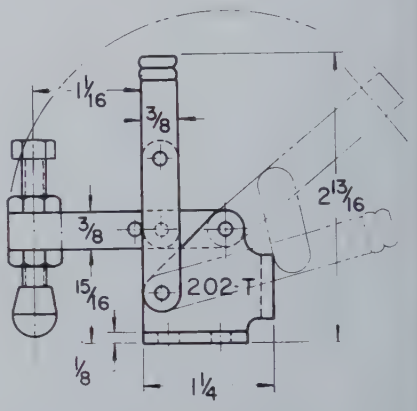


FIG. 4. Portion of standard template supplied by Detroit Stamping Company.

The template file at Ingersoll-Rand Company's assembly machine section consists of full-, half- and quarter-scale drawings, each including data on usage, mounting, dimensions, etc., see Figure 5. All commercial and proprietary standard parts and assemblies in regular use are included in the file. As a result, many of the drawings required for a not-too-complex new installation can now be prepared in an estimated average of 70 per cent of the time formerly required. Further, the level of experience needed has dropped sharply and the standardization resulting from this work achieves savings in manufacturing and assembly time.

Other firms have used special templates held in position on a metal board with magnets, then photographed the result, proceeding from this point with conventional reproduction techniques. This method facilitates juggling of a layout and combines accuracy and speed.

II. Drafting Media

Continuing developments in drafting papers, cloths and films have produced attributes far beyond those available even a few years ago. Because a piece of vellum worth a dollar may well receive several hundred times that value in drafting labor and may guide the production of many thousands of dollars worth of hardware, it would appear sensible to de-emphasize the first cost when selecting departmental paper. A second major principle, therefore, is to select a drawing medium which will lead to lowest total costs. The following factors should be considered.

(1) Drafting. Can a harder pencil be used on the proposed medium while achieving equal contrast between line and background? If so, there will be fewer stops for pencil sharpening and the result will be a cleaner, sharper and probably more accurate drawing. Also, consider resistance to pencil gouging and embossing, to smearing of lines, to tearing and to "ghosting", puckering, or abrading under severe erasing.

In a recent instance, a heavily embossed part number was erased from an assembly drawing on vellum, but the embossing picked up dirt and reinstated itself. The resulting confusion was quite costly. Other points to keep in mind are these. Does the material take pencil or ink well after erasing? Does it pucker while lying on the board, inviting tears, or does it lie flat through humidity changes. Before making any decisions, a test of each medium is strongly recommended, especially of the newer and less well known materials.

(2) Printing. High transparency gives better prints at lower cost. However, the medium must be proven to resist ultraviolet rays, and wrinkling, tearing, and curling.

(3) Storage. The two characteristics essential for storage are mechanical resistance to tears, wrinkles and dog-earing, and chemical stability to maintain transparency.

A new medium scores outstandingly on all three counts; i.e., polyester drawing film. This polyester film is unusually transparent, facilitating tracing and speeding printing. The latter advantage is compounded by the fact that even a 6H pencil produces an intense line, yet may be speedily and easily erased many times. This accelerates drafting and should more than repay the first cost—around 21 cents per square foot, in quantity. Polyester films are also virtually indestructible, with none of the tears, rips and dog-earing so often experienced with vellum. A thickness of about four mils is suggested to prevent embossing by hard pencils which, if erased, leave "ghosts."

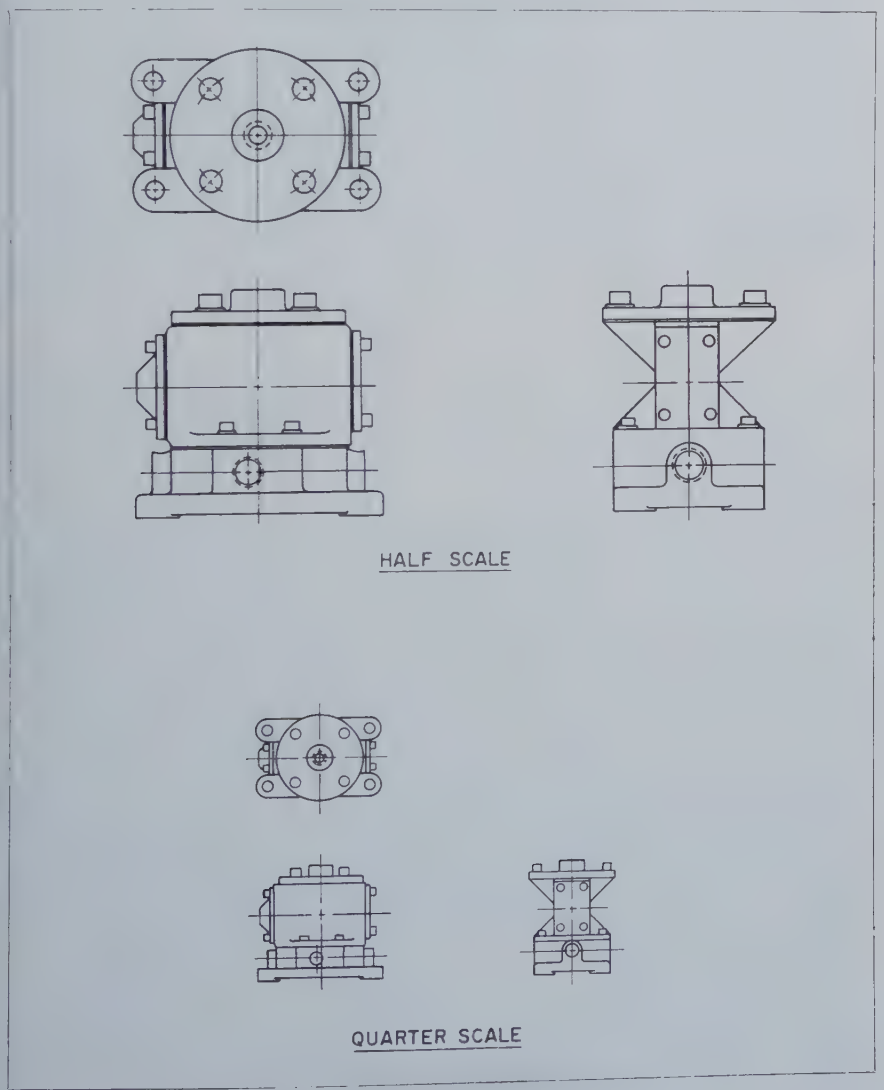


FIG. 5. Portion of template from Ingersoll-Rand's file. These templates are white-printed for insertion in a loose-leaf book distributed to each designer and draftsman.

Free-Hand vs. Accurate Drawing

Two divergent trends have developed. The first is to draw free-hand to save time in drawing preparation. The second is to draw with maximum precision and use the drawing as a layout tool. In the latter case, the image of the part is transferred to the metal of each part or tool by contact printing after applying a sensitizing solution. Thus, one precise layout made under favorable conditions in the drafting department replaces many layouts in the shop. Specially processed glass cloth and polyester films have been used because of high dimensional stability.

III. Reproduction Processes

The use of intermediates to eliminate or minimize tracing has been termed *photodrafting*. This introduces the third principle, which is to make free use of the latest advances in reproduction processes. This cuts down not only on labor, but on checking and on errors as well. Intermediates, or "reproducible reproductions" are used to restore worn out tracings, to generate duplicate "originals" for more economical printing and protection of originals, and to facilitate engineering change and redesign. There are basically three processes, each with merits for particular situations.

Single-Step Intermediate

The single-step intermediate is is fast and relatively inexpensive. Of these, the diazo (sepia) is cheaper, but is not always as permanent as the single-step silver intermediate. Either can produce excellent quality, fast-printing copies on any desired medium. These copies can be altered by masking (blocking out) large areas in printing, or by chemical or mechanical erasing and then redrawing.

Two-Step Intermediate

If extensive changes are to be made, however, the two-step process is indicated. In this, a first transparent intermediate is made, then scissored to edit unwanted material. A second intermediate can be overlaid to form a composite drawing; from this the final (working) intermediate is made. If a negative process is used, lines and background are easily removed from the negative by rapidly brushing opaque over undesired portions. A final positive intermediate such as a photocloth can then be prepared, giving intensified lines and generally better quality than the original; it should, however, be checked for faint lines lost by the process, or portions of lines inadvertently opaqued out. Use of this process permits two drawings to be combined, or a drawing may be superimposed on a new title block format.

Microfilm

The third basic photodrafting technique is microfilm. By photographing an original with reflected light, it is often possible to automatically drop out background and dirt, saving opaquing time. Portions of a number of different drawings or templates may be easily combined as desired. A further advantage of this versatile technique lies in the fact that the finished "drawing" can be smaller in scale than the original. Reduction to half-size (for example, a "C"-sized drawing reduced to 8½ by 11 inches) is a procedure often used to turn out large runs of convenient-to-use assembly and installation prints. Aside from other benefits, such reduction can, as a rule, be justified economically with a run of 16 copies or over.

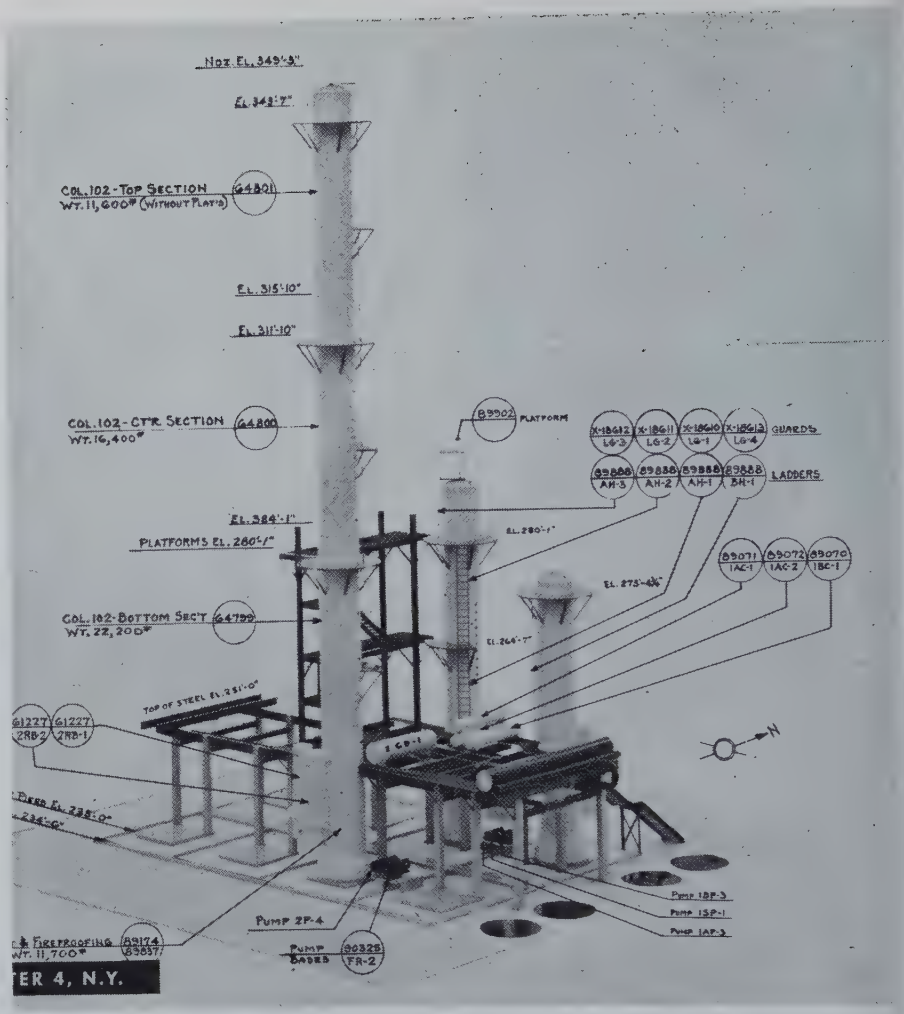


FIG. 6. Three-dimensional study model of industrial process serves also as construction guide in this photodrawing, supplementing conventional plot plan at Eastman Kodak.

Microfilm has many other benefits which can only be touched on here. It gives protection against fire or loss. It saves file space. In conjunction with suitable viewing equipment, it speeds access to files. Recent developments in military procurement indicate that microfilm images mounted on aperture cards will soon be required in lieu of the blueprints formerly shipped with hardware. Where a company does business with the Department of Defense, this new trend makes it imperative for the chief draftsman to restudy his operation. The reports of many firms suggest that, rather than a hardship, this requirement is a blessing in disguise.

Photodrawings

Many hours of drafting time can be saved by substituting photos for line drawings; see Figure 6. Eliminating the need to check whether drawings are up-to-date, this technique is especially useful in showing desired changes in existing equipment. The changes can often be marked in freehand on a photoprint. Other applications include showing assembly steps in training new operators, guiding inspectors, or showing exploded views. Because the camera does not have a discriminating eye, distracting backgrounds must be minimized; fade-out or retouching techniques are often employed to gain emphasis. By pasting up and rephotographing at full size, any desired photo series may be put on a title-block form, or incorporated into an existing drawing; see Figure 5. Prints can be made on standard diazo papers.

Patternmakers and others frequently ask for three-dimensional views. These are apt to take longer than warranted unless the draftsman has had special training. However, photographic techniques can readily supply these views for incorporation into a drawing when model parts are available. Such instructions are more easi-

ly read by untrained personnel than orthographic projections.

VI. Equipment

The past decade has seen an explosive development of new tools to aid the draftsman. Some are simply gadgets and many duplicate each other's function. Nevertheless, the availability of new tools presents an opportunity for worthwhile time savings and improvement in draftsmen's morale. Our fourth precept might, therefore, be phrased as follows. Usable or not, the equipment of the last decade is not necessarily good enough for the next!

The Typewriter

An ad reads, "Why waste your high-priced draftsmen on simple lettering jobs when your office typist, using the Vari-Typer, can do these jobs four times faster?"

The same possibility exists for conventional typewriters with carriages big enough to hold the drawings in question and, because typewriting is compact, it is often feasible to reduce the drawing size at the same time. Why, then, haven't we embraced this method for the long list of materials, specifications, notes and instructions required on many of today's drawings? The answer seems to be that all too often the man in charge—who knows what is needed—has given up pleading with management—which controls the money. It is often easier to get a $15,000 annual salary allowance for draftsmen than to put through a $1,500 equipment appropriation for the same job.

Pencils

Fortunately, savings can also be made in little things—pencils, for instance. The ideal pencil is conveniently shaped and light in weight, produces a line at least 200 per cent denser than the drafting medium, and requires a minimum amount of time to keep the point sharp—as it must be for clean, clear work.

These criteria dictate an end to the pen knife and antiquated file or sandpaper sharpening block, costing as much as $75 per year per man according to a time check by the author. Instead, manual and electric rotary sharpening devices, vibrating sandpaper blocks or mechanical pencils should be provided. The latter, with thin leads that need no sharpening are recommended for a series of long lines, rather than for detail work. There should certainly be an electric eraser to remove unwanted lines, for this can mean a saving of 15 minutes per day, returning the purchase cost of around $22 in about one month.

Drafting Pens

From those who must work with ink, we have all heard comments about pens continually running dry. The wide-blade ruling pen is one answer. There is now a push-button ruling pen, refilled from a cartridge in the handle. There are also special fountain pens and steel spring-leaf brushes suitable for ink and providing constant-width lines for filling in areas or lettering.

Other Devices

The devices that help determine what the pen or pencil puts on the paper are also important. For those who for various reasons prefer to continue with the string-type parallel rule, recently impoved with antifriction bearings, a triangle is suggested that is easy to pick up and shift and then does several jobs at once.

The drafting machine combines scale, triangle, protractor (or adjustable triangle) and straightedge in one integrated unit and time savings from 10 to 50 per cent have been claimed for its use. Unlike scale and straightedge, which are always sliding down, the drafting machine can be used on sharply tilted boards, often the most effective drafting position and certainly the most glare-free. However, the counterweight needed on such sharply tilted boards can be a hazard and a nuisance. Moreover, it is difficult to draw large layouts accurately with steel band or linkage-controlled machines. Recently there has been a swing to the X-Y track-type unit, which overcomes both objections; see Figure 7. In deciding between the various types of equipment, consideration should include first-cost, habit and training time.

In school we were taught elaborate ways of constructing perfect or approximate ellipses. Now this protracted chore can be eliminated with templates or by any of several ellipsographs or "circular drawing machines." Other 3-D devices include semi-automatic machines for axonometric and perspective rendering, or simply specially ruled paper, available from most suppliers.

Another gadget of interest—except perhaps where simplified drafting is practiced—is the cross hatcher. Such gadgets permit faster and better looking work than "eyeballed" cross-hatching. They are available built into the drafting machine or in the form shown in Figure 8. Other such time and work savers as adjustable curves,

FIG. 7. X-Y track-type drafter has counterbalance spring or weight, locks either track for long lines and is available in standard sizes. (Emmert Manufacturing Co.)

FIG. 8. Push-button cross-hatching device. (Koh-I-Noor Pencil Company).

proportional dividers and dotting and double-line (railroad) pens, quick-adjusting compasses and pocket-sized computers should also be available in the drafting department.

Figure 9 shows a type of equipment which unfortunately seems little known outside the art department. If a part is placed on the copy platform, the image may be projected below and traced in 3-D without waiting for photographs. Existing photographs or templates can be enlarged or reduced (to 4X) and traced on the spot, without distortion or lost time; the price is about $400.

The light box is an all-around utility device. It is a time-saver when tracing poor prints, comparing details with assemblies, or when checking interferences through several layers of tracing paper. Other uses include inspection of transparencies and X-rays, stripping-in and opaquing of negatives and preparation of Multilith and Mimeograph masters. A portable unit, such as that pictured in Figure 10, is sometimes preferred to the more familiar tracing table because the portable unit does not occupy space in the drafting room, but may be brought to the user's board or desk and then stored.

Stool and Board

Toward day's end, the draftsman equipped with an old-fashioned, round, backless, cushionless stool is back-weary and often cranky, certainly in no condition to turn out his best. If the firm can afford posture chairs for the secretaries and the factory girls, it can certainly afford them for the much better-paid draftsman.

The board is at least as important to continued efficiency as the stool. Instead of working in a cramped or stretched position much of the day, the draftsman finds the work always at the right height on one of the new, fast-adjusting boards. A tilt backwards brings the title block to a convenient position, while a quick forward tilt makes the top of the drawing accessible. In short, he is always within the "normal working area" sought by the methods engineer for maximum efficiency. If a man gets a bit leg-weary sitting down, he stands for a while, because the board goes up with him. This is the old "sit-stand" principle, also recommended by methods experts in the factory. Preference should be given to equipment on which a single quick movement can achieve position adjustment or the adjustment will not be used as often as it should. Such easy-shift boards can make a substantial contribution to output, to the appearance of the drawing and the room and to morale, while garnering a side profit in the form of floor-space savings up to 40 per cent. The right-angle arrangement shown in Figure 6 provides a highly accessible reference area and combines desk and drafting board into a handsome unit for the design engineer. It is commonly available in sizes up to 40 by 50 inches.

Studies indicate time savings up to 35 per cent for quick-adjust boards on large, complex drawings. If we assume 15 per cent savings a fair average, then such a board will pay for itself in less than a year.

FIG. 9. Art projector throws image on board below. (J. A. Engle Co., Inc.).

FIG. 10. Portable tracing unit is easy to store. (Porta-Trace, Inc.).

Lighting

Illumination levels recommended by the Illuminating Engineering Society have been going up year by year, simply because each increase has been found to pay off in better quality and quantity of work. In 1956, for instance, a level of 50 foot-candles were recommended at the working surface for drafting. Now the level is up to 150 foot-candles; for a board tilted at 60°, this means that 300 foot-candles are required, measured on a horizontal work surface.

Such an illumination level is approached by suspending over each board a louvered or plastics-diffused fixture with two 215 watt (96″) power-groove fluorescent lamps.

Because of present high tilt angles, the fixture is hung parallel to the tilt axis of the board, rather than at 45°. Light floods upward from the fixtures, and this is best reflected back down by a matte-finish white ceiling. The resultant direct-indirect lighting minimizes glare and eliminates the need for frequent manipulation of the individual board lamp.

The Author

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Operations and Procedures for Engineering and Drafting Supervisors

Parts III and IV

by George C. Schmidt

Quality control and waste reduction are the direct personal responsibility of the supervisor—and nothing reflects on and points out his shortcomings quicker than re-work due to poor quality, and waste due to poor planning. Only if he knows the causes of poor quality and of waste can he take steps to improve the situation.

III. Control of Quality and Reduction of Waste

Some of the factors likely to have a bad effect on quality of work and to lead to waste are the following.

a. Size of the Project. On a small job the worker has a fairly good over-all picture of what is going on. He knows the problems created by errors and probably knows personally the man who will be hurt when he falls down on the job. But the man on a big job may contribute in a very specialized way to the finished product, and sometimes he will have no real knowledge of the direction in which his work is tending, or the exact part his work plays in the job as a whole. Under such circumstances, he takes less pride in quality.

On large projects, therefore, a primary responsibility of supervision is to create pride in quality work. The larger the project, the greater is the responsibility for planning placed on the supervisor.

b. Over-Supervision. The supervisor must, above all things, avoid any practice which would imply a lack of responsibilty on the part of the workman. "Over-supervising" is such a practice. When quality control is emphasized by more and more direct supervision and checking, the workman tends to develop the feeling that the responsibility for quality rests on the checker or supervisor. "Let him worry about it. That's his job," is the worker's attitude.

c. Working Conditions. The worker cannot help but feel that the regard which a company has for good work will be reflected in the quality of the working conditions it provides. The attitude of a worker is very often determined by the example set by his supervisor in insisting on good housekeeping and in insisting that house and equipment be properly maintained. No one can do good work with poor equipment, and if a workman is handed "beat-up" equipment or sloppily prepared documents, he cannot be blamed for assuming that the company has no real interest in good work.

"Operations and Procedures for Engineering and Drafting Supervisors, Parts III and IV," by George C. Schmidt, is the continuation of an article begun in the December issue of GRAPHIC SCIENCE. The concluding portions of this article, "Improvement Studies and Work Simplification" and "The Rating of Workers" will appear in forthcoming issues.—Editor.

d. Perpetual Job Crises. These perpetual job crises to which all of us are constantly being subjected—drawings needed "the day before yesterday"—is a direct reflection of poor planning and a lack of proper emphasis on orderliness. When a workman complains that he can't do good work because he is always being rushed, something should be done about it and very soon.

e. Fatigue Factors — Older vs. Younger Workers. Fatigue factors are important, especially with respect to the older workers, and the good supervisor will show consideration for the old timers. They may not be as spry as the younger men, but they have learned to save themselves a lot of work by doing things the easier way, and the supervisor can pick up a lot of good ideas from them. The older worker has the benefit of experience; he is anxious for security and is much more likely to be punctual and dependable. He is not inclined to engage in horseplay and other dangerous and time-wasting practices. The supervisor who uses discretion in the assignment of the older personnel, pairing the older men with younger men who can benefit by experience, for example, will find it paying off well in improved quality and reduction of waste.

The supervisor who overtaxes the older men by expecting too much from them—even if "that's part of their job"—is very short-sighted indeed.

f. Shifting the Worker. Changing men around too much also undermines morale. A man who is constantly picking up his instruments, leaving something half-finished, and jumping on to something else will have a poor opinion of the supervisor's planning ability. Furthermore, every new start involves some sort of "make ready" which, however necessary it may be, contributes nothing tangible to the job. Every man does better work when he can carry a job through to a logical conclusion instead of constantly adjusting himself to new problems and new conditions. Also, men who have grown accustomed to working together will work with a minimum of direct supervision. They seem to sense the needs of one another and this makes for good teamwork.

g. "Different" Activities Require "Different" Men. Another source of waste and poor quality work is the familiar "square peg in the round hole". There is always, within the range of a classification, a variety of different activities—and some men do better on one thing than another. The good supervisor learns to size up new men and assign them where it will do the most good. Lack of interest often comes from the fact that the employee himself knows that he is not suited to the particular task he is doing, but feels that there is not much he can do about it. His frustration can affect quality.

h. Quality Work Standards. Once a standard of quality has been set, the supervisor must insist that it be maintained. The supervisor cannot expect the worker to believe that he wants top-standard performance if he has been willing in the past to accept less than standard when pressed for time. The danger here is that the worker will begin to question the importance of the standard.

i. Encouragement and Commendation for Good Work. The supervisor is all wrong who takes the attitude, "What's the matter with these men anyway? Are they getting soft? Do they want me to baby them and nurse them along? They're supposed to do good work, aren't they? They get paid for it, don't they?" Such an attitude is very impractical. If commended, a good man will continue to do a good job, knowing that he is appreciated by his supervisor.

j. Maintaining Proper Discipline on the Job. Too much stress cannot be laid upon the importance of maintaining proper discipline on the job. Skylarking, horseplay, and other "tomfoolery" do more than waste time. They are dangerous. A job is no place for a comedian or practical joker.

Good workers may have personal peculiarities or physical handicaps or characteristics which are likely to make them the butt of the more ignorant of their fellow-workers. The supervisor has an added personal responsibility toward such men. He must nip in the bud any inclination toward ridicule. From the very start, he must make it clear to those under him that anything of this sort, or the sending of new or inexperienced men on fool's errands, will not be tolerated.

k. The Supervisor's Self-Inventory. Before the supervisor blames the shortcomings of his men on the fact that he has "too many men to supervise", it would be well for him to take an inventory of himself. If he has not learned to instruct, train and inspire his men to do good work without constant overseeing, he will have an endless job of supervision and will always have "too many men to supervise."

l. Worker's Suggestions. Quality is bound to suffer when the supervisor ignores suggestions. If a worker thinks he has an idea which will improve work or conditions, the supervisor should listen. If the idea cannot be put into practice, the supervisor should take the time to explain why.

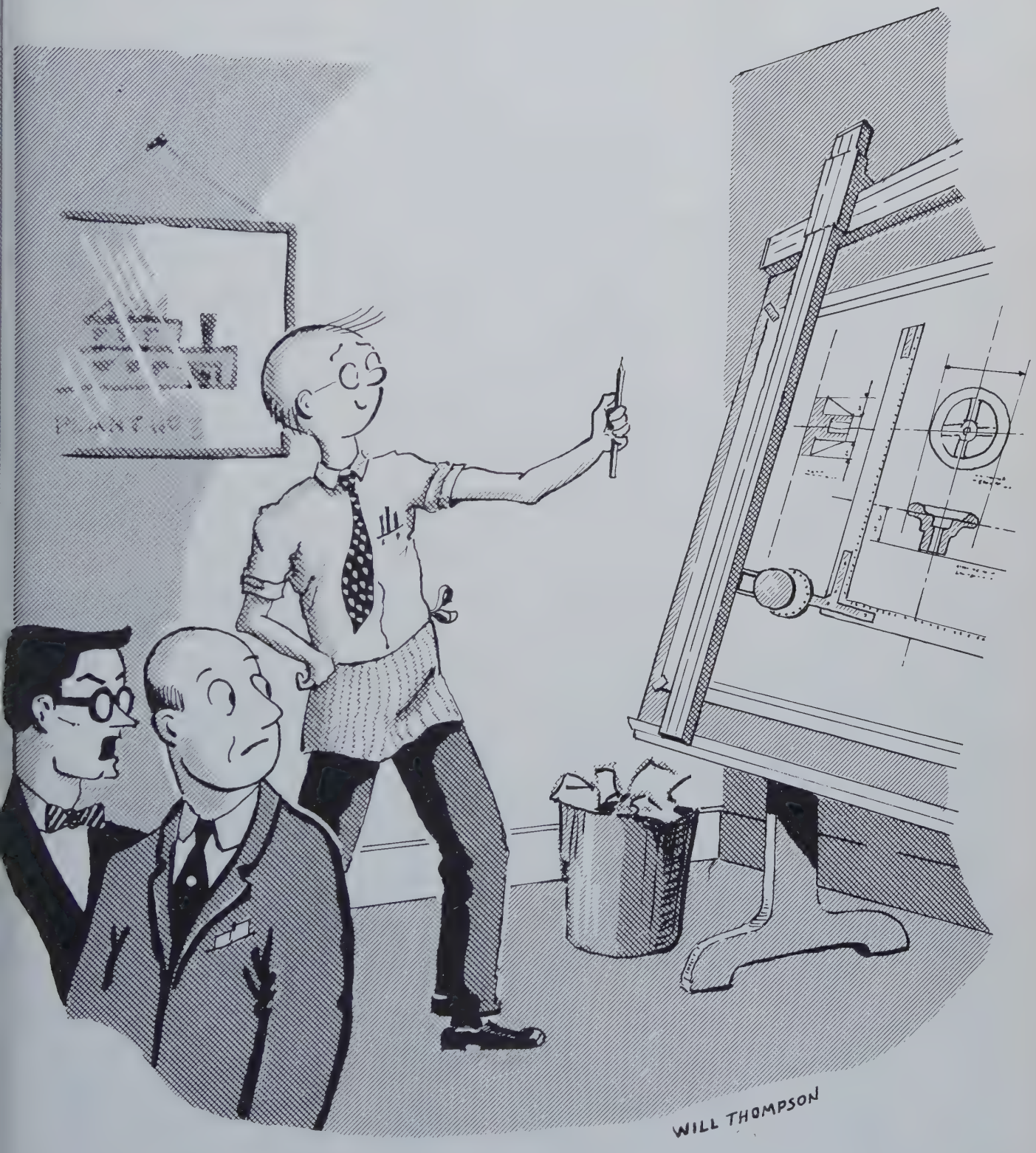
m. Worker's Request for Job Assistance. A request for help should never be ignored. And a request for help addressed to a supervisor should receive immediate attention. A man will usually turn to his boss for help only after he has exhausted every other source. He hates to go higher up for help because he is likely to feel that doing so is a reflection on his own abilities. Therefore, the man who asks a superior to help him out is usually very much in need of assistance.

n. Reactions Against Good Workmanship. Undeserved blame will react against good workmanship, and every workman should have his chance to explain when it appears he is at fault.

The wrong approach is to try to say right off the bat who is right or who is wrong. The right approach, and one that will often accomplish wonders, is to get together in deciding WHAT is right as opposed to WHAT is wrong.

o. Favoritism. Favoritism will inevitably hurt quality. It is only human to favor those we like, but unfortunately the reason we like them may have nothing to do with their ability or performance on the job. Favoritism always brings a supervisor into contempt. It is a sword that cuts two ways: those favored become lax in their work because of what they think they can get away with; those not favored become dissatisfied, angry, resentful, and finally indifferent.

p. Criticism of the Worker. When quality goes down, criticism of the worker is in order, but there is a right and a wrong way to criticize. If criticism must be given the supervisor should, if possible, bracket it with some commendation. Start off with good points of the worker, bring up the criticism, end up with other good points. It is possible to do this if you will sit down and take the time to actually list the man's good points. Use tact. Don't let him go away think-



"He's been doing that ever since he enrolled in the Famous Artists School."

ing, "I can never do anything right for that guy!"

Planning and Scheduling

In planning and scheduling you set out on paper a systematic sequence of operations and allot time (both on the calendar and in man-hours) to perform the operations.

On a small job with a limited number of men, the problem of planning work and scheduling it is relatively simple. Most men on the job are familiar with the over-all picture as it concerns themselves and have a general idea of what others will do. In such circumstances, the job-load is sufficiently small to be centralized under the personal supervision of a very few men and instructions for the various operations can be passed along by word of mouth. In such cases, very formal and detailed paper work is an unnecessary burden.

However, on bigger jobs, management has been forced to look for a substitute for some of this "talking it over" between vice presidents and plant managers, and between supervisors of different levels and areas of operations. What this formal planning and scheduling seeks to accomplish is: (1) maximum quality at minimum cost through the most effective distribution of work to available manpower and equipment, (2) added flexibility of personnel and equipment to meet unavoidable emergencies, and (3) harmony and cooperation between departments and sections within departments with a clear understanding of what is expected from each.

Unfortunately, some supervisors believe that written instructions schedules and follow-up make change difficult. When this is true—and it sometimes is—management is probably guilty of trying to make the job fit the system instead of adapting the system to the job. But, while planning is done with the expectation that it might have to be changed, a supervisor and the men under him must realize that they and their work are but parts of a large operation and that unnecessary or capricious changes in the operation of one section or department will affect and may even disrupt the work of several other groups.

At this point, one thing should be made very clear. When the planning and scheduling for a job have been determined and set up they represent company policy, and it is the personal responsibility of every supervisor to give his whole-hearted support to the program. Responsibilities imply obligations. When a man accepts the responsibilities of a supervision, he assumes the obligation of full cooperation in the carrying out of company policy. A supervisor can, however, cooperate most effectively when he has a good understanding of the general background of planning and scheduling.

The schedule is not a straitjacket—it is a valuable instrument. It is designed to help the supervisor and not to cramp him.

It is obvious that catch-as-catch-can operations have no place on a big job. Equipment, materials and manpower have to be where they are needed when they are needed. The hiring of skilled technical men in sufficient numbers to man the job properly is not the same thing as hiring an odd-jobs man to mow your lawn. You cannot hire dozens of engineers or draftsmen for two days' work this week with the expectation of terminating them at your convenience and rehiring them for a day or two next week.

No, the plans for the purchase of materials, the provision of equipment and the hiring of men must be worked out well in advance, and just as carefully as any other phase of the planning.

Schedule of Operations

This is done in a general way on a Master Schedule of Operations which is prepared by working backward from the critical date—the completion date. This is the date with which there is rarely any possibility of compromise. The company may have a great deal of money "riding" on that date. Perhaps forces of trained personnel are to begin producing at that time. Raw materials may be flowing into the plant for processing; production schedules have been set up to meet delivery for which the company is obligated to its customers.

The second most critical date is that on which the engineering department can "get going."

Between these two dates are all the headaches, and the more of them that can be ironed out ahead of time, the better off for everyone concerned.

A good system of planning and control calls for full utilization of the experience, knowledge and ideas of all concerned. It does not change established practice materially, either with respect to labor or supervision, or does it limit or supplant normal authority and prestige of those in management places.

General planning for an engineering operation normally begins with a discussion meeting. It should be held soon after the scope of the work has been established and is attended, as a rule, only by department heads or their representatives. This is a policy meeting and it is not intended that much detailed planning be done. Critical dates are established, key employees selected for assignments, and basic approaches determined.

Procedure Planning

After the policy meeting, Master Procedure Planning Sheets may be prepared which show all available information about the job, not only for the engineering but for the work for which the engineering is being done. These Procedure Plans include preliminary estimates of equipment, material and labor requirements, required dates for the purchase and delivery of major or special materials, and necessary dates for starting and completing the different parts of the work. The Plans are accompanied by explanatory notes and copies are distributed to all departments and work sections.

When jobs are large or complicated, production supervisors and engineering supervisors work together in setting up key dates, thus saving the time required for meshing separate schedules.

At a second meeting, held as soon as possible in order to complete the general planning, everyone is brought up to date on conditions and the Master Procedure Planning Sheets are corrected, particularly as to the dates shown, so that they will be acceptable and practical for all departments concerned.

Major Items of Work

The next step is the planning of the Major Items of Work—going into more detail than was possible on the Master Procedure Planning Sheets. There are a number of questions to be answered, among which are: What job organization is required?

What type of equipment will be needed? What parts of the work are to be subcontracted? How can more detailed information be developed on deliveries? What production procedures are to be followed? What material must be purchased immediately? What special requirements must be met? Are special policies indicated? What major methods studies are required? What will be the sequence of operations generally? What will be the sequence of work within the separate operations?

The Master Procedure Planning Sheets will then be reworked, if necessary, to reflect the results of the investigations and detailed studies.

Construction Schedule

It is from the corrected Master Procedure Planning Sheets and the general studies of major items of work that the Construction Schedule is developed. This document shows all major items of work, the time required to perform each, the estimated labor requirements, and their respective places in the schedule.

The items on the Construction Schedule are general, and some of them are too comprehensive. These will require further study and progressive breaking down until they lend themselves readily to step-by-step planning.

This basic planning has been presented in some detail so that you will understand that nothing is left to chance if it can be foreseen and provided for. The company has made commitments to production. The highest supervisor or project engineer has made commitments to the company management by sitting in on the preliminary planning and accepting the Construction Schedule as a basis for his performance. He now passes on this obligation to lower supervision by defining the scope of work which is to be covered by the Weekly Progress Schedule with which supervision is most closely connected.

This Schedule is prepared to serve two major purposes: (1) set out the work to be done during the period covered by the Schedule, and (2) list the estimated manpower requirements for the accomplishment of that work.

Each of these aims, though considered separately, must mesh. It is unsatisfactory to use all available manpower on scheduled work with a low percentage of completion (over-scheduling), or to do all the work scheduled with low utilization of manpower (under-scheduling).

It takes considerable knowledge and a lot of thought to prepare a manpower schedule.

The Supervisor as a Connecting Link

The supervisor is a connecting link between management and workers and has a direct responsibility to both. On one hand he is responsible to management for getting the work out. On the other hand he is responsible to his workers for the efficient scheduling which will develop a smooth curve allowing for steady and effective use of manpower.

The supervisor can promote these mutual interests of management and the worker only by constructively participating in planning and scheduling and taking the schedule seriously. If he has the work of his department well in hand, he should be in the best position to advise on the combination of jobs which will advance the project

as a whole as far as his men are concerned. His suggestions can cover the avoidance of extra "development" time, the haphazard shifting of workers and other wasteful practices. He can suggest alternative scheduling which will result in greater economy and efficiency and provide for the freeing of manpower which may be needed in an emergency.

Each supervisor also has a cooperative responsibility with other supervisors. Scheduling is a service to the department as a whole and to the individual jobs in progress. It can be effective only if it has the sincere cooperation of those it serves.

If the purpose of planning and scheduling are to be achieved, the supervisor must ask only for an honest and fair allocation of manpower and time for a given item of work. It is only natural for him to ask for extra allowances to make things easy on himself and to avoid getting behind schedule. A certain amount of delay may be unavoidable and some extra allowances should be recognized as advisable in efficient scheduling. Yet the supervisor who takes undue advantage of this opportunity is failing in his part of the cooperative effort and is disrupting the planning efficiency of the entire organization.

Record Keeping

A supervisor has the responsibility for keeping current, complete and accurate records of the work under his supervision. The amount of assistance he will receive in keeping such records will vary with his position, the job and the organization. But the fact that he will receive staff or clerical assistance does not relieve him of his prime responsibility. Since he is responsible for the work, he must have at his finger tips concrete information regarding work in progress and work scheduled.

It is the further responsibility of the supervisor's superiors and associates to keep him well informed, at all times, as to the progress of the work in the field. This to assure compliance with the anticipated demands of the schedules involved.

Scheduling as a Cooperative Function

Scheduling is a cooperative function and staff-help may have to coordinate activities and accomplish the actual preparation of the schedule. This involves two dangers: The supervisor may feel that, since there is a special department or individual to plan and schedule production, his own responsibility has been cut down or eliminated.

Since the responsibility for the physical preparation of the schedule has been taken from him, the supervisor may not appreciate the problems involved and consequently may be non-cooperative in making and revising the schedule.

1. Preparation. Weekly meetings should be held for preparation, revision and adjustment of schedules, and under this arrangement the schedule as issued is the joint responsibility of all those who attend the meeting. Each supervisor is called upon to accept or reject the conditions imposed by the schedule. At this meeting he is able to gain information regarding the plans and problems of others and the effect of a change in the schedule on all concerned. He therefore must ask for a change or accept the schedule with full knowledge of the scope of his responsibilities. The schedule which is worked out at such a meeting will be accepted by supervision and supported and followed through by them in a far different spirit than would be one sent down to them as a "command from on high."

The schedule is a "dispatching instrument"—or should be. It is designed to release and control the movement of men and equipment to different work places, the movement of records and data necessary for each operation; the recording of the time of beginning and the expected time of completion, the coordination of the sections, the control of progress on operations and the making of the necessary adjustments to conform to emergencies.

2. Follow-up. Effective follow-up is perhaps the most important and the most difficult of planning activities. Planning and scheduling will be of little value if there is no adequate machinery for informing those concerned when emergencies demand departure from the schedule. The procedure for procuring data and information must provide for a follow-up which will insure that it will be on hand for a specific job when it is needed.

Certain men may be assigned the responsibility for follow-up: expediters in the case of matters relating to procurement; planning assistants in the case of coordination and "arrangements". Their function is primarily one of obtaining information and passing it on to those who must be informed. They are essentially "go-betweens" performing a service.

3. Procurement. The following up of material is primarily the function of the Purchasing Department but is a matter with which the drafting supervisor should have some concern to the extent that procurement is related to the bills of material and drawings developed during the design phase.

Although the purchasing responsibility is not directly one of the engineering or drafting supervisor, it is he who suffers the ill-effects of poor follow-up. When he has to make major adjustments of his work and disrupt the smooth operation of his department because of someone falling down on the procurement job or failing to inform him of a change in drafting requirements for setting delivery dates, he may well feel it to be within his rights to inquire as to the follow-up procedure which has broken down and failed him. Frequently a group of supervisors may collectively formulate suggestions and press for improvements. The weekly meeting provides an excellent opportunity for the discussion of such problems.

4. Emergencies. Emergencies requiring schedule changes should be real emergencies. Otherwise, more convenience will be given emergency status and very soon half the work is on an emergency or non-scheduled basis and the schedule has become just another piece of paper. There is also the danger that when so much is labeled "emergency", the urgency of the label is so watered down that real emergencies are not given proper consideration. There must be some flexibility in an engineering schedule. Nevertheless, the supervisor, having taken part in the discussion of the schedule and knowing the effect that changes will have on others, must exercise his "priority powers" with intelligence and discretion.

The Author

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Drafting Time-Savers

Title blocks, notes, instructions, sub-assemblies and standard components, are pre-printed on adhesive-back tri-acetate and permanently applied to drawings

By Stanley Maas

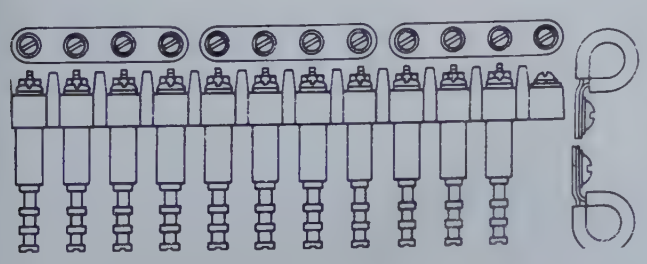
Pressures on drafting room time are steadily intensifying because of the increasing intricacy of drawings required for today's electronic and avionic devices. In most drafting rooms the added time required to draw complex equipment and the shortage of qualified personnel have combined to create a bottleneck.

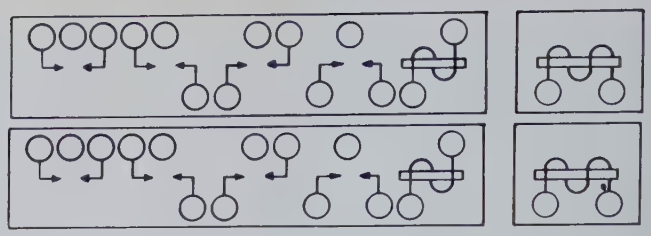
One answer to this problem is the use of pre-printed tri-acetate sheets.* Originally developed to provide non-smearing title blocks, the pre-printed material is now finding application in a variety of standard shapes, notes, bills of materials and even entire sub-assemblies.

The required material is reproduced by a photo-engraving process and printed on the back of a tri-acetate sheet; transparent, pressure-sensitive adhesive is applied to the front face. The adhesive will not bleed under the heat of a blueprint machine and, according to the manufacturer, the tri-acetate will stay in place forever unless manually removed. A protective backing sheet keeps the adhesive clean and free from contamination. One end has no adhesive, to permit removal from the backing sheet. This edge has the date of manufacture printed on it and the product carries a guaranteed shelf-life of one year from this date.

The device can be applied to a tracing in about 15 seconds. The draftsman first removes the protective sheet. The tri-acetate is then placed in position on the rear of

*The printed tri-acetate sheets discussed and reproduced in this article are manufactured by Stanpat, Whitestone 57, N. Y.





the tracing and is made to stick by rubbing with a soft cloth. Since the tri-acetate is applied to the rear of the drawing, the draftsman can add information by hand-lettering on the face of the drawing itself. For 30 minutes after application it is possible to remove the sheet from the drawing, if necessary, and then to reapply it. After that, the tri-acetate is permanently bonded in place. One hour should elapse between the time of application and blueprinting to give the adhesive time to bond. These tri-acetates can also be printed for front application for microfilm work or photo reproduction. The surface is treated so as to make it very receptive to pencil or ink.

The biggest potential use of these acetate sheets appears to be in replacing hand drawings of parts of sub-assemblies that appear on a large number of tracings. Items like nuts, screws, bolts, electronic tubes, standard motors, pumps and small wiring diagrams can be printed up as individual sheets and applied as required, or a sheet can be printed with several standard parts. Detail drawings of parts used most often can be printed with letters as dimensions; the draftsman tailors each drawing by substituting numerical values for the letters.

To custom-build a control unit, for example, the draftsman places as many of the printed component sub-assemblies on the tracing as required. These may then be joined into a complete control unit by pencil lines. Since details of the sub-assembly are checked before the acetate drawings are made, the checker need only make sure that the proper sub-assemblies were used and that they were correctly connected.

Printed instructions allow the draftsman to save the time required to hand-letter standard information. For non-standard notes, the typewriter may be used on blank acetate forms. This note is then applied to the front of the tracing—instead of the rear—and the drawing need not leave the drafting table for its application. The special typewriter ribbon employed is also suitable for regular work.

Terms such as "For Estimate Only," "For Experimental Use" and "Top Secret," that may change during the life of a tracing, are printed on acetate sheets having a temporary adhesive. These can be removed and new classifications added as required.

A further use of the adhesive-backed acetate is in the repair of torn tracings. Strips of blank acetate make invisible repairs that will not reproduce in blueprinting. Heat from the blueprinting machine does not affect the bond.

The Author

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(*Continued from page* 14)

of study on the part of the Chief Draftsman. The whole report is only as good as the estimate of how complete the drawings are. This can be done most effectively by going over the drawings one by one and estimating their per cent completion. Where a project consists of several hundred drawings, this gives a surprisingly accurate estimate.

In estimating the per cent completed for each drawing, the historical data can be very helpful. Rules of thumb can be established on the historical data, such as: When the preliminary design is finished the drawing is 20 per cent completed; when the finished drawing is completed and ready for checking it is 60 per cent completed; when it is checked and issued to the client for approval it is 85 per cent completed; and when it is issued for construction it is 100 per cent completed.

By careful analysis, you can arrive at the per cent that the entire project is completed. If you compare this total with the per cent of the entire estimate used and the schedule, you are able to decide whether the project is in good or bad condition on an overall basis, and what corrective action, if any, is required.

If it is decided that a project requires corrective measures, categories causing the difficulty can be determined from the report.

This system is meaningless without the application by Management of corrective measures when they are required.

The third tool of this system represents, on a running curve, the overall per cent completion and the estimated progress. (Figure No. 4). By plotting these figures against time, you can establish how effective the corrective measures have been.

In most cases the pattern for a project is pretty well established by the time it is 30 to 40 per cent completed. At this time by dividing the per cent completed into the manhours expended a very accurate prediction of the final costs can be made. Since the progress curves always take the same general shape (we know this from experience), it provides a visual tool for estimating a revised completion date. For example, it is quite unlikely after a project is 60 per cent complete to expect any increase in the slope of the curve.

Notice on the sample curve (refer to Figure No. 4) when the project was 40 per cent completed it was running about 5 per cent behind. Five per cent behind for 40 per cent completed indicates an expected over-run of about 12 to 13 per cent. Notice that when this job was completed, the original appropriation was over-run about 10 per cent. This then represents all the important facts concerning a particular project in a very simple form.

What are the facts that can be learned from these curves? First the job is behind schedule. This may be so because men were not available when necessary, or it might be that the information was not available from the client when it was required. You should satisfy yourself as to just what is the cause of this delay. Was it because of incompetent supervision? Has the pattern been set? Has there been any change in scope? What is the new completion date? These are the answers that a competent Manager should know.

Conclusion

Cost accounting enables the Chief Draftsman to predict the future and adjust the present, but to make any quantitative predictions about how much this kind of system can reduce costs is very difficult. It is possible that achieving the control described here can decrease drawing production costs in excess of 25 per cent, not because of the system, as such, but because of the corrective measures that it brings about when these can still do some good.

Since this completed system was achieved at Day and Zimmermann it has been our experience that production rates as measured by manhours per square foot have been cut very nearly in half. But just as important, periodic analysis of production vs. cost has created an atmosphere of cost consciousness among the people who are responsible for them.

The Author

Harry M. Perks is Chief Draftsman, Day and Zimmermann, Inc., Engineers, in Philadelphia, Pa. This article is based on a talk given by the author at the Effective Drafting Management Institute held at the University of Wisconsin, October 8 and 9, 1959.

Graphic Perspective

by Eleanor W. Thompson

THE PAPER on the board of a 20th century draftsman is an expendable item, apparently inexhaustible in supply and possessing uniform characteristics of excellence. In fact, those charged with ordering paper for drafting room use are faced with the difficult task of choosing wisely from a bewildering assortment of papers, cloths, and tracing films and of determining what reproduction techniques offer most advantages.

In marked contrast with this abundance was the paucity of materials which possessed a surface capable of taking the imprint of a writing or drawing tool 2500 years ago. A list of these ancient materials must include leaves, bark, clay, leaden and wax tablets, the papyrus roll, and the parchment book. However, their endurance — that of the papyri and the parchments in particular — is a source of continuing amazement to the scholars happily exhuming them.

To establish a perspective for viewing the accelerating technology of papers and reproduction techniques today, we shall attempt to review briefly the history and nature of the principal writing materials of antiquity.

Papyrus

PAPYRUS SHEETS were the most common writing material of classical antiquity. They were in constant use from about 500 B.C. to 300 A.D. Papyrus, or Egyptian paper, was made of slices of the cellular pith of a sedge-like plant *Cyperus papyrus*, arranged in layers, each at right angles to the preceding layer. The layers were moistened with water, pressed, dried and then smoothed by rubbing with ivory or shell. These handmade sheets, varying from 5 by 9 inches to 9 by 15 inches were then made into rolls from 20 to 30 feet in length.

The long papyrus rolls are historically credited with possessing several of the same disadvantages as the large rolled tracing of today; *i.e.*, they were awkward to use for reference, having to be re-rolled after each use, and often the beginning and end of a roll would be torn or mutilated from excessive use.

Parchment and Vellum

PARCHMENT was known to have been employed for literary works in Rome as early as the 1st century A.D., and it was used by the Greeks much earlier. By the 4th century A.D., Greek and Latin literature was generally transferred from the papyrus roll to parchment. Fine parchment was prepared from the skins of kids, lambs and young calves, while coarser parchments were made from the skins of male goats, pigs, and wolves. From about the 10th century until ordinary paper became available in Europe, parchment was virtually the only writing material employed.

Originally, sheets of vellum were prepared by cleaning, drying and polishing the *gut* of the calf or lamb, but the term is also applied to the skins of these animals, or goats, prepared to make a fine quality parchment. The finest qualities of vellum, which have retained their smoothness and firmness for as long as fifteen centuries, were made from the skins of unborn calves and lambs.

We hasten to add that parchment- and vellum - like papers today are made from materials other than the skins of young animals!

Paper

THE ORIGINS of paper are lost in the mists of Chinese antiquity. Tradition has it, however, that paper was first made in the year 105 A.D., by Ts'ai Lun, a eunuch attached to the court of the Chinese emperor, Ho Ti.

For nearly 500 years, papermaking was confined to the Chinese empire. The Arabs became acquainted with papermaking in the 8th century as a result, it is said, of the successful seige of Samarkand where a papermaking factory was located. Introduced into Spain and Italy in the 12th and 13th centuries by the Arabs, the craft of papermaking had spread northward to most of the countries of Europe by the 14th century.

The earliest known paper still in existence is estimated to date from 150 A.D. It was made from rags, and it is interesting to note that the best papers today are still made from rags. In fact the basic process of hand papermaking has not changed in more than 1800 years. The process involves two stages: the breaking up of the raw fibers of cellulose (drawn basically from the woody portions of plants) in water to form a suspension of individual fibers; and the formation of felted sheets by spreading this suspension on a suitable porous surface through which excess water can drain.

Rags of linen or hempen cloth were the main source of cellulose in 18th century papermaking, the advantage of their use being that extraneous matter had already been eliminated from the fibers in the textile process. Many attempts were made to devise substitutes, but it was not until the first half of the 19th century that the ground wood process of pulpmaking was introduced. The first of the chemical pulp processes appeared shortly thereafter.

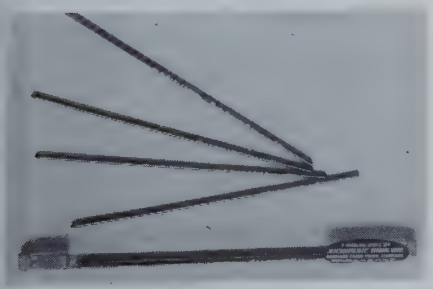
More About Paper

THE LONG HISTORY of papermaking, complex and fascinating, is barely suggested in the foregoing brief commentary. Therefore, in subsequent columns, we shall continue to explore the subject as it relates to the wealth of drawing materials available in today's drafting rooms.

New Products

Microfilm Reader

Readability and minimum maintenance are said to distinguish a new designed-by-request microfilm viewer with special optical and viewing screen lighting systems. Called Designer "184," the unit has an 18- by 24-inch screen; it is built by The Filmsort Co., Pearl River, N. Y., Div. of Minnesota Mining & Mfg. Co. In addition to the special 65mm f/4 lens, the reader uses a screen angled between 15 and 20 degrees to provide a comfortable reading angle for the engineer with bifocals. Drawings from 8½ by 11 inches to 17 by 22 inches, when filmed at 16 to 1 are brought back almost to full size. Larger drawings filmed at 29 to 1 or 30 to 1 are restored to half original size.



Drawing Leads

Two drawing leads for use in a mechanical holder are available in a clear, plastics tube closed with a clasp containing a Pink Pearl eraser. These Microtomic drawing leads (No. 6100-2), available in eight degrees, are produced by Eberhard Faber Pencil Co., Crestwood, Wilkes-Barre, Pa.

Spray-on Adhesive

The development of a new type of adhesive in a pressurized spray can have possible implications for drafting and paste-up of copy for reproductions. The spray-on adhesive, known as Quik-Stick, is colorless, odorless, and non-toxic, and can be used to hold any smooth surface, including paper, plastics, blueprints, drawings and the like, to any other smooth surface, including glass. The material, made by Maker Products, Inc., Irvington on Hudson, New York, may be applied, then the material it coats can be removed and replaced in different positions or on different surfaces many times, while still retaining the adhesive coating. In this respect, the adhesive gives to any flat surface the characteristic of certain types of adhesive tapes.

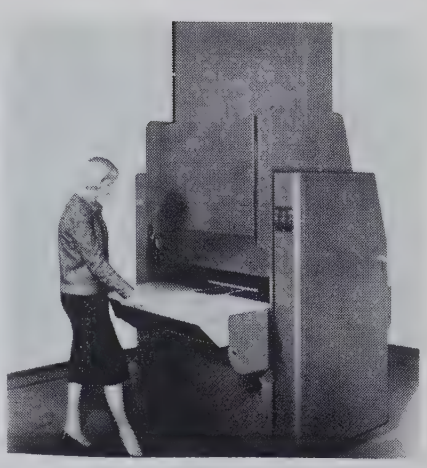
Copying Machines

Two new diazotype copying machines for the engineering profession have been announced by Charles Bruning Co., Inc., Mount Prospect, Ill. The Model 600 is reportedly built much the same as the deluxe Model 675, but is said to have greater flexibility in that optional accessories may be added to meet specific needs and budgets.

Bruning's Model 320 is a new tabletop diazo copying machine with a 42-inch printing width. This Copyflex accommodates sheets or roll stock of any length. Standard developer, drying and feed and delivery systems are incorporated in the Model 320.

Typewriter Ribbons

Both fabric ribbons and carbon ribbons are now supplied as standard accessories at no extra cost on Remington electric typewriters. According to an announcement by Remington Rand Division of Sperry Rand Corporation, 315 Fourth Ave., New York 10, N. Y., the new two-ribbon feature makes it possible for the machine to function equally well in the preparation of correspondence in photo-offset work and for multiple copy work.



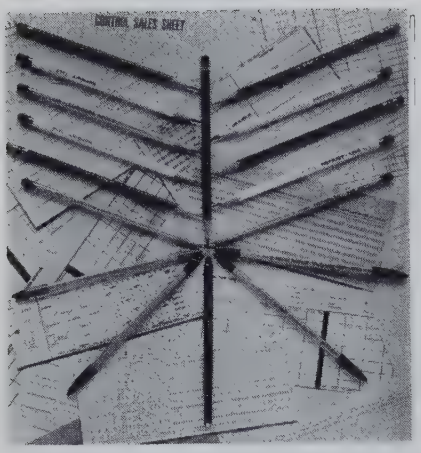
Enlarging Camera

A continuous-flow, enlarging camera has been designed by Carroll B. Collins of Pittsburgh, Pa., primarily to blow-back the card-size "Neoprints" made in the Neoflow reducing camera either to full-size or to any desired enlargement less than full size. However, the camera is also suited for general photo - copying work. It is being nationally distributed by Peerless Photo Products, Inc., Shoreham, L. I., N. Y. Originals—either opaque or translucent—can be fed into the Neoflow Enlarger either continuously or intermittently. They can be of any width up to 15 inches and any reasonable length. The camera can enlarge these originals to 2, 3, 3½, 4, 6, or 7 times the size of the original; it can also reproduce them the same size as the original. Maximum width of the enlargements is 30 inches; they can be of any length.

Drafting Equipment Case

A wedge-shaped box has been designed that fits under five sizes of drawing boards to permit drawing to be done conveniently on any level surface; the box also provides storage of a complete complement of drafting equipment, including a T-square. The unit, called the Oliver Drafting Equipment Case, is made by Oliver Mfg. Co. 1436 Payne, Wichita 3, Kan. The box is made of ½-inch clear white pine, has a brass chest handle for easy carrying and a felt or flannel bottom for safe use on any surface.

New Products



Special Writing Instruments

A line of pencils and ball pens designed for use with such processes as Diazo, Photocopy, Facsimile, Verifax, Thermofax, and Zerography, has been announced by Eberhard Faber Pencil Co., Crestwood, Wilkes-Barre, Pa. The new line has 11 pencils and five ball pens of various colors and writing densities. They include the Blak-Print and Fotorite pens, the Litho-Print, Fotorite and Contak Pencils. Another pencil, the Noprint, is designed for marginal notations and instructions, not intended to be reproduced by a photocopying machine.

Printer-and-Processor

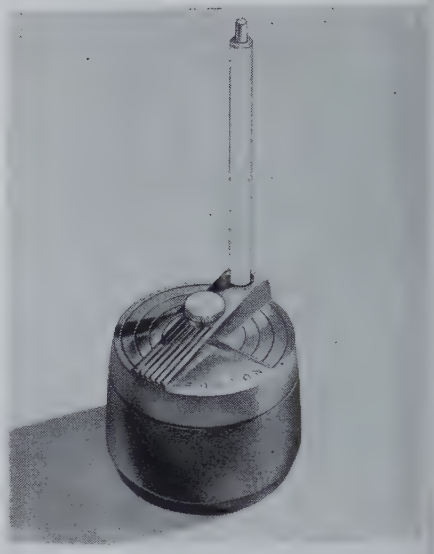
The silver photography process, which develops and stabilizes a print almost instantaneously, is incorporated in a photo-copying machine recently introduced by Peerless Photo Products, Inc., Shoreham, Long Island, N. Y. The equipment initially offered is capable of copying material up to 9 inches wide and of any length. Tradenamed Quick Silver, the process uses a photo-sensitized material with a silver-halide type of emulsion that can be used under normal lighting. Exposure can be either reflex or print-through. The machine uses a single sheet of sensitized paper to make a copy. By exposing the original in contact with this sensitized sheet, a right-reading stat copy (white or black) is obtained. This can serve as the finished copy, or it can be used as a "master" to make positive copies. Any number of positives can thus be made from one master.

Table Model Whiteprinter

Prints up to 42 inches wide by any length can be made at speeds up to 15 lineal fpm with a recently announced whiteprinter. Called the Revolute Rockette, the unit is produced by Paragon Revolute Corp., 77 South Ave., Rochester 4, N. Y. According to the manufacturer, the developing speed is synchronized with the printer so that longer prints can be started through the developer while part of the print is still being exposed; in other words, production capacity is not limited to a fixed developing speed. The machine is powered with a 1/15 hp electronic drive. Light source is a 1500-watt quartz high-pressure mercury vapor lamp located inside a 4-inch diameter revolving contact cylinder. If desired, the machine can be purchased complete with floor stand having a lower compartment for storage of sensitized material.

Optical Mounter

A semiautomatic optical mounter that centers, checks and mounts microfilm for automatic reproduction has been announced by The Filmsort Co., (Div. of Minnesota Mining & Mfg. Co.), Pearl River, N. Y. Before mounting the film into the card, the operator aligns center lines of the microfilmed image with those calibrated on the 14- by 14-inch screen; the projected data on the mounter screen is also compared with the posted data on the card to make certain the right frame of film gets into the right aperture card. Mounting is automatic; the operator presses a button and a motorized film die cuts the film frame from the roll and seals it to the aperture card. As the die returns to its starting position, the next film frame advances automatically. The film spool holds either 100 or 1,000-foot, 35 mm. microfilm reels. According to the manufacturer, use of the unit permits an operator to mount an average of 300 to 400 frames hourly.



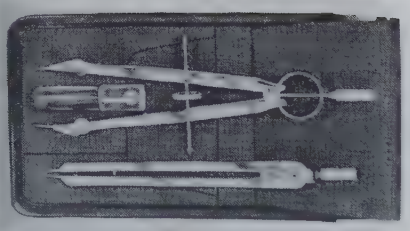
Lead Pointer

The development of a new lead pointer, designed to give the draftsman short, medium, or long tapered points on his lead has been announced by C. Howard Hunt Pen Co., Camden, N. J. The choice of points is controlled by simply adjusting the length of the lead. Called the Boston Lead Pointer, the unit can be used in either a portable or fixed position. To replace the abrasive, the user throws away the old abrasive cup and drops in a new one.

Shading Film

For uniform shaded effects on line drawings, a Mylar sheet—surface-printed with opaque ink—saves drafting time. Called Contak, the shading film is produced in a variety of patterns, including standard Ben Day screens. Its reverse side is coated with a clear, pressure sensitive adhesive, protected by a backing sheet. To use, the draftsman scores a section slightly larger than desired; the cut is made through the printed plastics film but not through the backing sheet. The film is lifted out on knife point, positioned and pressed firmly on the copy. Surplus film is cut and peeled away. Chart-Pak, Inc., of Leeds, Mass., producer of the shading film, also prints patterns, symbols and title blocks to order. All Contak shading film may be used in diazo equipment and for projection by transmitted or reflected light.

New Products



Basic Drawing Kit

The two instruments necessary for layout and measuring—a full 6-inch bow compass and a 5½-inch friction divider—are available in a pocket kit for drafting room or general shop use. Produced by Alvin & Company, Inc., 611 Palisado Ave., Windsor, Conn., the kit, No. 608K, is priced at $3.95. Both instruments and spare parts tube with extra divider needle come in a 6¼ by 3½-inch black vinyl case. The case is fitted with a pocket flap and has an extra compartment for storage of pencils, scales, etc.

Diazotype Photo Paper

Plastics-coated paper with a new type of black image diazotype sensitization has been introduced by Ozalid Division, General Aniline and Film Corp., 35 Corliss Lane, Johnson City, N. Y. Called Hi-Gloss Black Dryphoto (108DZ), it reportedly will reproduce a black, glossy, photographic-type print of a film positive in seconds. The film positive is laid over the Dryphoto material and run through any diazo copying machine; a dry, black, high-gloss photograph results. According to the manufacturer, with the Dryphoto material, it is possible to reproduce in a diazo machine, every tonal gradation in a photographic continuous tone film positive, with a grainless image. The Dryphoto can resolve more than 100 lines per millimeter. Developed for fast, dry reproduction of continuous tone aerial photographs used primarily for military reconnaissance and aerial mapping, Hi-Gloss Black Dryphoto can also be used with automatic dodging equipment to produce glossies directly from dodged continuous tone positives. This eliminates the need for the second negative normally required.

Black-line Cloth

A black-line cloth intermediate, said to possess good line-holding characteristics and printing latitude has been introduced by Ozalid Division, General Aniline and Film Corp., 37 Corliss Lane, Johnson City, N. Y. Called 101 CZB Blue Tint Ozacloth, the material has a double matte surface, to provide a universal writing surface suitable for pencil, ink or typewritten characters. Corrections can be made with an eraser. Since the new Ozacloth is a black-line material, it shows no "pinking" of the background on development or aging. According to the manufacturer, it is not affected by slow printing speeds of poor masters; neither will it stick to the cylinder when reprinting to slow processing papers, cloths or film specialties.

Interchangeable Type

The problem of typing technical material which may include engineering, mathematical or chemical symbols, has been met by a typewriter recently introduced by Remington Rand, Div., of Sperry Rand Corp., 315 Park Avenue South, New York 10, N. Y. Key to this versatile machine is interchangeable typewriter type, removed from or returned to, two extra type bars by the typist "in a matter of moments," to quote the manufacturer.

Punchless Binder

Binders requiring no punched holes are said to be suitable for holding engineering drawings, reports and catalogs. In place of rings or other devices fastening through punched holes, a spring-action clamp opens or closes in response to finger pressure. The binder is manufactured by Acco Products, Div. of Natser Corp., Ogdensburg, N. Y. Binders come in colors.

Portable Microfilm Reader

A low-cost engineering reader, capable of enlarging a microfilmed drawing six times to fit an 8- by 8-inch screen, has been announced by The Filmsort Co., (Division of Minnesota Mining & Mfg. Co.), Pearl River, N. Y. Called Inspector "50", the unit covers the Filmsort "D" aperture. Weighing about five pounds, the reader is 12- by 9- by 4-inches in size. It has storage space for 200 aperture cards.

New Literature

Drafting Room Time-Study, a blue-bound booklet containing the results of tests conducted for Franz Kuhlmann K.-G. by Batelle Institute, may be requested from Franz Kuhlmann K.-G., Prazisionsmechanik und Maschinenbau, Wilhelmshaven, Germany. Among the world's largest manufacturers of drafting machines, Kuhlmann developed the first drafting machine in Europe. Some interesting statistics on drafting efficiency are given, along with time and motion study diagrams and typical drafting room layouts. Kuhlmann offers, without charge, to submit space-saving suggestions if supplied with scaled drawing of drafting area.

Whiteprinting Brochure, describing seven Ozalid Whiteprint Machines manufactured by Ozalid, Division of General Aniline and Film Corp., Johnson City, New York, may be obtained by writing to the company and requesting Form No. SP58-33. Whiteprinter models covered in the brochure range from the desk-top "Bambino" to the new "Printmaster 1000" that turns out copies up to 54 inches wide at rates up to 100 fpm. Specifications are given for each model.

Pressure-Sensitive Materials Catalog, *Visualization Made Easier,* containing complete ordering information for all components of the Chart-Pak System, may be obtained by writing to Chart-Pak, Inc., Leeds, Mass., and requesting Form No. E58-100M-A59-75M. An extensive group of lines, bars, shapes, patterns and symbols commonly used in preparing charts, graphs, maps and layouts are included. These items are all precision printed on pressure-sensitive, adhesive-backed tapes or sheets.

Drafting Machine Bulletin, M-70, outlines the major characteristics of Model 70, a unit, recently announced by Glideline Corporation, 300 South Potomac St., Waynesboro, Pennsylvania. Among these are exceptional lightness, and a double Vernier protractor which is visible throughout 360°, automatically indexing at 15° increments.

Pressure-Sensitive Tape Brochure (Form No. 4-LE59RN-M) lists materials required and gives step-by-step instructions for simplified two-sided circuit layout. The brochure may be obtained by writing to W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.

Slide Rule Brochure (Form No. 22846), titled *Slide Rule? May I Help. . .* by Don Herold, gives model numbers and descriptions of K & E's full line of slide rules, from pocket-type to Log Log Duplex Trig. The illustrated brochure may be requested from Keuffel & Esser Co., Hoboken, N. J.

Microfilm File Cabinet Specification Sheet (Form No. 3995-554), giving data on six- and nine-drawer microfilm file cabinets with humidity control, is available from Graphic Microfilm Corp., 115 Liberty St., New York 6, N. Y. These file cabinets are manufactured by Yawman and Erbe Mfg. Co., Rochester 3, N. Y.

Over 200 Tracing Templates, shown full-scale, are available free upon request to Northwestern Tools, Inc., 117 Hollier Ave., Dayton 3, Ohio. These tracing templates were designed for companies which manufacture jigs, fixtures and special machinery. Tool designers will find them helpful in selecting the correct items for their designs and in reducing layout time.

Blueprinting Machine Brochure, titled *The Revolute M4 Automatic Blueprinting Machine,* describing a continuous printer and finisher for both blueprints and VanDykes, may be requested from Paragon-Revolute Corp., 77 South Ave., Rochester 4, N. Y. Schematic diagrams of the machine, extensive machine design information and specifications are included.

Filmcard Reader Bulletin, a sheet listing features of Griscombe Filmcard Readers designed for 16 mm. and 35 mm. microfilm—mounted in aperture and jacket cards—is offered by the distributor, Graphic Microfilm Corp., 112 Liberty St., New York 6, N. Y.

Letters

(*Continued from page* 5)

Sirs:

Congratulations! I have enjoyed your first issue of "G. S." very much. I found "Scribing" of particular interest and as a matter of fact have just discussed with a K&E representative the possibility of its application in a pantograph which we use to develop miniature templets for engineering studies. Looks like it has real advantages here also.

JAMES CUCCI

Rayco
Paramus, New Jersey

Sirs:

Quite by accident I acquired a copy of the first issue of Graphic Science and I have found it most interesting and informative. It was circulated in our drafting and design group and was very well received. The article, "Appraising the Drafting Operation" by Charles H. Bayer was of particular interest, as were the report on ASA Drafting Standards and the New Products section.

JACK R. WEITFLE

Idaho Design Engineering Associates
Idaho Falls, Idaho

Sirs:

I would like to receive subsequent issues of Graphic Science for myself and subordinate supervisors listed on the attached facsimile questionnaire. All are qualified, by their supervisory status or job assignment to receive free subscriptions.

It was a genuine pleasure to peruse the October issue which was also reviewed with enthusiasm by our group supervisors. We believe Graphic Science is destined for recognition as "the magazine" in the field of drafting and reproduction, an integral function of engineering.

W. D. CAVENDER

Aeorjet-General Corp.
Sacramento, California

Editor's note: Subscription Questionnaires appeared in the October, November and December issues. Additional copies are available from Graphic Science, 103 Park Avenue, New York 17, New York.

The Editor's Board

The Turn of The Wheel

A DRAWING can only be as valid as the engineering and design ideas that go into it, and an engineer who cannot sketch out the concepts he has in mind must rely on the draftsman or the designer.

This growing area of responsibility for draftsmen was the topic of a thought-provoking article by Professor Irwin Wladavar, Associate Editor, in the first issue of GRAPHIC SCIENCE (October 1959). Since then, a great many comments—from other professors and instructors of engineering graphics, from draftsmen and drafting department supervisors, and from engineers — have been forthcoming.

THERE SEEMS TO BE general agreement that engineers should want and be able to draw but a continuing reluctance on the part of many school and university administrators to reconsider their basic curricula, and reinstitute fundamental drafting courses.

At the January meeting of the Engineering Graphics Division of the American Society for Engineering Education, the need by industry for engineers who can draw will once again be voiced. Earl D. Black, Head of Engineering Drawing, General Motors Institute, will present a report entitled "Industry Speaks About the Needs of the Young Engineer." His paper is based on contacts and interviews with more than 120 individuals in 20 divisions of General Motors Corporation and six other major companies. Their concensus is that drafting ability is as important to the success of the engineering student's subsequent career as basic theory.

Is the engineering student or the engineering school dean convinced?

THE WHEEL TURNS. Part of the cause for decline in drafting skills and current dis-interest by engineering students and educators in them may lie with industry.

For many years, drafting departments have been boxed in by more highly regarded engineering, manufacturing, and sales departments; the design-drafting supervisors have not had the voice in company affairs they needed to hold their own. The draftsman has, in many instances, found himself in a similar position. And this fact is not lost on engineering administrators in schools and universities, nor on the engineering student.

Might it be that when the drafting skill is more clearly rewarded, engineering students and young engineers will be a great deal less reluctant to "work on the board," and engineering schools to teach them how?

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GRAPHIC SCIENCE SUBSCRIPTION APPLICATION FORM
(Make a facsimile of this and return it, if you haven't done so yet.)

GRAPHIC SCIENCE IS FOR SOME—NOT ALL

IN ORDER to receive subsequent copies of GRAPHIC SCIENCE, the Questionnaire below must be completed and returned to: Editor, GRAPHIC SCIENCE, 103 Park Avenue, New York 17, New York. A facsimile can be filled out and mailed if you would like to keep this issue intact. All Questionnaires will be acknowledged.

Your free subscription to GRAPHIC SCIENCE will be continued if your job involves: (1) The supervision of draftsmen or a drafting department. (2) Supervision of reproduction or drawing-filing personnel or departments. (3) Supervision of technical illustrators or technical photographers. (4) Teaching of engineering drawing or graphics. If you do not qualify and wish to receive GRAPHIC SCIENCE, the subscription rate is $8.00 per year in the United States, $9.00 per year to Canada; $10.00 to other countries.

Your free subscription will be discontinued if the questions below are not answered. The information you supply here will never be divulged. In coming issues, however, we will summarize the data received, reporting results for your own information.

May we hear from you shortly?

Name: _____

Title: _____

Company: _____

Address: Street _____

City _____

State _____

Company product or function: _____

_____

_____

Your job function: _____

_____

_____

_____

Number of personnel in your department:

_____ Draftsmen _____ Reproduction

_____ Designers _____ Checkers

_____ Technical Illustrators _____ Others

I've been working in my present job for _____ years.

Check one:

_____ I'm qualified to receive GRAPHIC SCIENCE free. Continue my subscription.

_____ Take me off your list.

_____ I don't think I'm qualified to receive GRAPHIC SCIENCE free, but I'd like to subscribe.
_____ Bill me. _____ Check enclosed.

There are other personnel in my firm who should receive GRAPHIC SCIENCE. Their names, titles, and addresses are as follows:

_____

_____

_____

(You may attach a second sheet, if the space here is not adequate. Extra Questionnaires are also available on request.)

Comments? _____

_____

_____

I'm interested in writing for GRAPHIC SCIENCE:

_____ Yes _____ No

Signed _____

Comparative costs your draftsmen should see

ADD to the pennies per sq. ft. cost of Kodagraph Autopositive Paper all the direct and indirect charges you can think of. You'll find it hard to raise the total cost of reproducing a 24 x 36 in. drawing above $3.00. A drop in the bucket compared to the estimated cost of retracing a complex drawing.

It just doesn't make sense nowadays to retrace even the smallest worn-out drawing . . . the smallest "repeat" design. Your chief draftsman, needless to say, will appreciate comparing costs with you.

***IMPROVED* Kodagraph Autopositive Paper, Translucent**

Exposure speed is stepped up. Line sharpness is greatly increased, while background density is decreased—giving you intermediates which produce sharper, cleaner prints. Greater roomlight tolerance, especially to fluorescent light, makes printing and processing easier.

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All the advantages found in new Autopositive Paper Translucent on an extra thin base. Gives you superb intermediates at a minimum cost. See for yourself how these NEW FROM KODAK reproduction materials make the job easier, better! Call your Kodak dealer or write:

Graphic Reproduction Division, Eastman Kodak Company, Rochester 4, N. Y.

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